UNIVERSITY OF ALBERTA

MICROFLORAL DIAGNOSIS OF THE CRETACEOUS-TERTIARY BOUNDARY, CENTRAL ALBERTA

by

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The undersigned certify that they have read, and recommend to the Faculty of Graduate Studies for acceptance, a thesis entitled "Microfloral Diagnosis of the Cretaceous-Tertiary Boundary, Central Alberta", submitted by Robert Garland Snead, B.Sc., M.Sc., in partial fulfilment of the requirements for the degree of Doctor of Philosophy.

ABSTRACT

Four geologic sections in central Alberta which span the contact between the Paskapoo and Edmonton Formations were measured, described and sampled for their palynological content. Previous studies, mainly of plant megafossils, vertebrates and nonmarine invertebrates from horizons slightly above and below the sampled interval had confirmed a Tertiary age for the Paskapoo Formation and a Late Cretaceous age for the Edmonton Formation.

The R.C.A. Core No. 65-1 was used as the standard section with which the microflora in three outcrop sections on the Red Deer River were compared. Three microfloral "zones" could be delineated based on species showing vertical and quantitative importance or those of stratigraphic significance, or both. Species characterizing the lowest and uppermost "zone" mark the Cretaceous and Tertiary units respectively. Many of these species are found in equivalent strata from South Dakota, Montana and New Mexico. A Paleocene age is designated for the lower Paskapoo microflora and a Late Cretaceous age is assigned to the microflora in beds immediately above and below the Mauve shale (Kneehills Tuff) Member of the Edmonton Formation. The middle microfloral "zone" is restricted to the uppermost Edmonton Formation (Ardley coaly interval), and carries abundant and restricted species.

Although no Late Cretaceous marker species were recorded in this interval, the microfloral assemblage compares much closer to that of the underlying Late Cretaceous beds than to the microflora in the overlying lower Paskapoo Formation. This comparison and the presence of several Tertiary marker species suggest that the uppermost Edmonton Formation (Ardley coaly interval) may contain the Cretaceous-Tertiary boundary.

Megaspores of the genera Balmeisporites and Azolla were recovered in large numbers. Eight new species of Azolla are described using a new approach to species classification which is based mainly on the wall stratification.

Species of the following genera are figured; Sphagnum, Hamulatisporis, Dictyophyllidites, Laevigatosporites, Reticuloidosporites, Polypodiisporites, Cingulatisporites, Leptolepidites, Sequoiapollenites, Taxodiaceaepollenites, Equisetosporites, Liliacidites, Vitis, Carpinus, Betulaceoipollenites, Alnus, Tilia, Cranwellia, Salixipollenites, Myrtaceidites, Symplocoipollenites, Cupuliferoipollenites, Rhoipites, Momipites, Ulmoideipites, Pandanus, Erdtmanipollis, Caryapollenites, Aquilapollenites, Scollardia, Tricolpites, Kurtzipites, Schizosporis, Ovoidites, Sigmopollis, Wodehousia, Balmeisporites, and Azolla.

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CHAPTER ONE - INTRODUCTION

Criteria for defining the Cretaceous-Tertiary boundary in Western Canada have been sought over the past half century. Lacking marine fossils, the diagnosis has rested on the disappearance of dinosaurs. Although collection of dinosaur bones identifies Cretaceous beds, absence of these remains does not of necessity imply a Tertiary age for the rocks. This study is concerned with the microflora in the strata from slightly below the highest observed ceratopsian dinosaurs in the Edmonton Formation to somewhat above beds of Paleocene mammals in the Paskapoo Formation. The palynological spectrum of this interval straddling the boundary has been examined. Generic and higher taxa of spores and pollen have been found to span the interval allowing for an assessment of specific changes in the microflora. It is hoped that these specific changes will permit a more accurate definition of the Cretaceous-Tertiary boundary in North American continental sequences.

Sedimentary rocks of Late Cretaceous and Early Tertiary age underlie a large portion of central and southern Alberta. The greatest thickness of these beds in the western Canada sedimentary basin are found along the west side of the Alberta Syncline (figure 1). Here the beds have been estimated in composite at a maximum of 10,000 feet. Rich coal

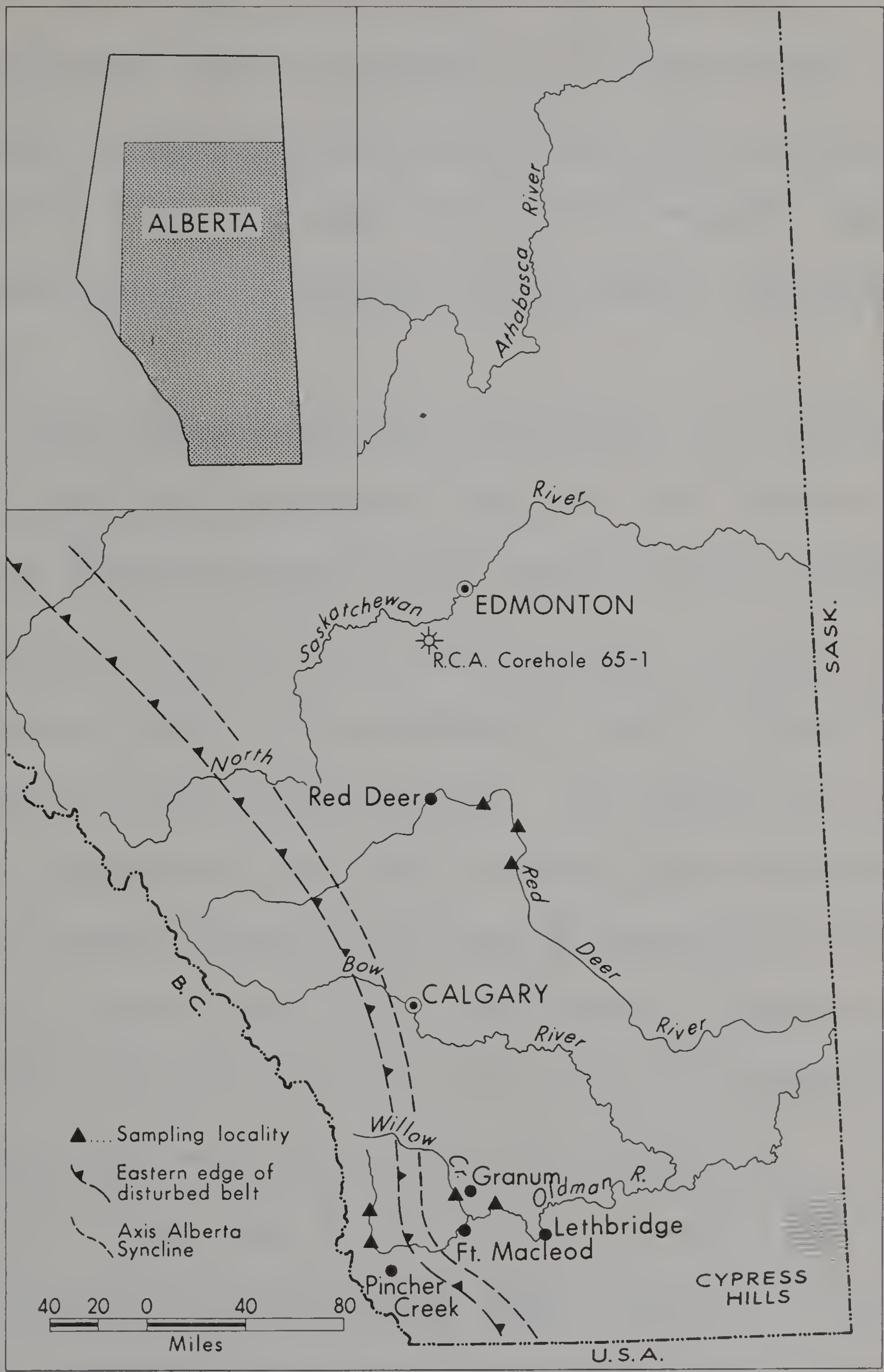

FIGURE 1. Section Localities in Central and Southern Alberta.

beds in the formations of both systems have spurred scientific and economic investigation over the years. The stratigrapher, when attempting to correlate these sediments with the contemporaneous strata in northern United States, finds few marker horizons and very few reliable index megafossils within this sequence of dominantly continental sediments.

This thesis describes the results of a stratigraphic study based on palynological data from the Uppermost Cretaceous Edmonton Formation and Lower Tertiary Paskapoo Formation of the Central Alberta Plains. A small amount of information taken from southwestern Alberta Formations of comparable age is also included. The purpose of the study is to distinguish the contact between Upper Cretaceous and Lower Tertiary strata by the use of palynology and to make lateral correlations, on the same basis, between the surface sections along the Red Deer River and a subsurface type-section cored near Buford, Alberta (figure 1).

The first part of this thesis describes the general stratigraphy and lithological units observed in the study areas. Correlation with the equivalent beds of southwestern Alberta, southwestern Saskatchewan and northern United States is also discussed. The later portions deal with the age and correlation of the microfloras, followed by a final section

containing systematic descriptions.

Previous Work

The Uppermost Cretaceous and Lower Tertiary of Western Canada have been studied by numerous (Western Canadian) geologists such as; Selwyn (1874), Tyrell (1887), Dawson (1883), Brown (1907, 1914), and Allan and Sanderson (1945). These investigators based their correlations and age determinations almost entirely on lithologic similarity and succeeded in outlining the broad stratigraphy which led to more detailed studies in the 1940's.

A saurian fauna discovered by Sternberg (1947, 1949) provided documented proof of the age and correlation of the Upper Edmonton beds of the Red Deer River Valley. Bell (1949) issued a comprehensive work on the megaflora in the uppermost Cretaceous and earliest Tertiary Formations of western Alberta. These data were supplemented by Tozer (1956) who made a detailed study of the nonmarine molluscan shells collected from the same strata. Mammalian fossils were discovered by Clemens and Russell (1965) in the uppermost Edmonton beds between the Kneehills Tuff and Ardley coal seam. In 1964 a joint party from the Universities of alberta and Kansas discovered three additional mammalian localities in the same area (Srivastava, 1966).

Several papers have been published dealing with specific areas or horizons of the uppermost Cretaceous and/or Tertiary of central, southwestern and southeastern Alberta. Ower (1960) investigated the type-section of the Edmonton Formation on the Red Deer River and scattered exposures on the North Saskatchewan River. He correlated the outcrop lithologies with subsurface sections between the two rivers with the aid of electrologs. An expansion of Ower's work was accomplished in a study by Elliot (1960) which encompassed an area from the Little Smoky River to Calgary. A tuffaceous bentonitic shale provided the only reliable continuous stratigraphic marker which could be used in these studies. This interval, known as the "Mauve Shale", contains a fine-grained siliceous tuff layer which has been subject to considerable investigation and stratigraphic use. On the basis of potassium-argon dating, Ritchie (1960) and Folinsbee _et al._ (1961) found that the Kneehills Tuff has an age of 66 million years. This tuff is distinct and easily recognized in outcrop, and has been traced from central to southwestern and southeastern Alberta by; Tozer (1952), Stewart (1943), Rutherford (1947), Russell (1932), Fraser _et al._ (1935) and Furnival (1946). In the folded Foothills section of southwestern Alberta, the Kneehills interval seems to be absent or unrecognized (Douglas, 1950).

Geologists have recognized for some time that the beds containing the Cretaceous-Tertiary boundary yield very little reliable paleontological data, and it was not until 1966 that an attempt was made to describe the microflora. Srivastava (1966) illustrated, classified, and described the microflora recovered from a composite section of the uppermost portion of the Edmonton Formation in the Red Deer River Valley. This study helped to provide the foundation for the present investigation.

CHAPTER TWO - LOCATION OF SAMPLES AND LABORATORY TECHNIQUES

Distribution and Sampling Localities

Rocks of the uppermost Cretaceous and Paleocene non-marine formations of western Alberta form a thick wedge of strata which are preserved in the Alberta Syncline to the east of the Rocky Mountains. The areal extent of these beds narrows from 175 miles in width near Edmonton to 30 miles in width west of Lethbridge.

Figure 1 shows the location of sampled outcrops and the subsurface core. R.C.A. Core Hole 65-1 was described and sampled in 1965. Because 500 feet of continuous core were recovered from this well and the sample yield percentage was very high, it is used as the standard section with which all outcrop sections are compared. Outcrops along the Red Deer River were sampled and measured in 1965. These latter sections together with R.C.A. Core Hole 65-1 constitute the essential basis of the study encompassed in the thesis.

Correlative beds of southwestern Alberta were measured and sampled along the Oldman River and Willow Creek in 1966. The sample yield percentage was very low, therefore, a detailed palynological analysis and comparison with the standard section was not possible.

Sampling Procedure

The general lithology of all sections consists of alternating claystones, siltstones and sandstones, but only the claystones, silty-claystones and dark-colored siltstones were sampled. Channels three to five feet long and one to two feet deep were excavated to acquire samples from outcrops. Composite samples were taken over continuous five foot intervals from the core. Spot samples were taken only from isolated claystone or siltstone partings in sandy horizons.

Sample Preparation

The maceration method used in this study follows very closely that used by Anderson (1960) and Singh (1964). Briefly, each sample was demineralized with HF (the more calcareous were first treated with dilute HCL), oxidized with Schultze's solution, suspended in potassium carbonate, wet-seived through a 100-mesh screen to collect megaspores, pollen and spores were separated from the minus 100-mesh portion in zinc bromide, and finally stained with safranin-O. Three slides were prepared for each sample; two using canada balsam as a permanent mounting medium and one using corn syrup.

The recovery of megaspores, mainly Azolla, was very

poor by the above method. This was possibly due to strong reactions in HCL and HF and probably because only 20 grams of sample were usually treated. Recovery was increased considerably in all samples, and was realized in samples otherwise found barren by using the following procedure:

(1) Forty to fifty grams of the uncrushed sample were washed and placed in a 1,000 ml. glass beaker partially filled with distilled water.

(2) The sample was brought to a low boil, with an addition of approximately 30 grams of Quaternary-O detergent, and allowed to completely break down.

(3) The sample was then wet-sieved through a 100-mesh screen. Material remaining on the sieve was searched for megaspores.

(4) The megaspores were then treated with HF from 8 to 12 hours to remove any mineralization.

All of the claystones, regardless of the degree of lithification, broke down readily within thirty minutes. This was also true of siltstones and sandstones which contained a matrix of argillaceous material. After recovery each megaspore was oxidized if necessary, washed in distilled water, dehydrated in methyl alcohol and xylene for

ten minutes, and then mounted in canada balsam.

Counting Procedure

Two-hundred and fifty grains per sample were counted in almost all samples of the Wizard Lake and Red Deer River sections. In rich samples only one slide was necessary to count 250 grains. With other samples, sometimes two or more slides were necessary for a complete count. When pollen was very scarce, counts of 100 grains per sample or less were made. After a complete count had been made and the grains recorded, the remainder of the slide or slides were scanned for rarer specimens.

Counting and photomicrographic work was carried out on a Carl Zeiss Polarizing Photomicroscope.

Codification and Taxonomic Approach

In order to facilitate the delineation of relevant species, the microspore and pollen in the present study were initially identified using an artificial system of nomenclature very similar to that described by Fournier (1964). The system is based entirely on morphological features. The nature and position of the aperture, colpi and pores constitute the most important features on which seventeen artificial groups were established for the present investigation. These groups were then subdivided

on the basis of the sculpture of the grain. Each group as well as each subdivision is coded. A tricolpate reticulate grain, for example, carries the code rt-16. The number 16 is the code for all tricolpate grains and rt is the code for reticulate sculpture. Lastly, the specific characteristics defining the morphologic entity such as size, exine thickness, labrum, outline, etc. are incorporated in the description. The first reticulate tricolpate entity found is recorded as rt-16-1 and the next reticulate tricolpate entity with different specific characteristics is recorded as rt-16-2 and so on. The same method is again applied to each subdivided group.

The coded morphologic entities pertinent to age determination and correlation have been reclassified formally using the taxonomic approach proposed by Rouse (1957).

Slide Repository

The microfloral slides are stored in the palynological collection of the Research Council of Alberta. The coding on each slide contains the following information: geologic section number, sample number and slide number or numbers. The code on all megaspore slides is followed by the letter M.

CHAPTER THREE - STRATIGRAPHY AND CORRELATION

The Late Cretaceous seas were characterized by numerous sealevel fluctuations which are reflected in the rocks from northern Alberta to those of the Texas-Louisiana Gulf Coast. The last major transgression into southern and central Alberta deposited the marine shales of the Colorado and Alberta Groups. With uplift in the west and regression of this sea, the coarse sands of the Belly River Formation were distributed throughout central, southern and southwestern Alberta, and southwestern Saskatchewan. In the foothills area north of the Bow River and north of the Athabasca River, the Belly River Formation was followed by an uninterrupted sequence of continental sediments which continued well into the Tertiary. South of these areas, the sea once again transgressed from the southeast resulting in the deposition of the marine sands and shales of the Bearpaw Formation (Table 1). After regression of the Bearpaw sea, continental conditions returned to the entire area and persisted into the Paleocene.

In the narrow portion of the Alberta Syncline south of the Little Bow River, the Bearpaw shales are overlain respectively by the Blood Reserve, St. Mary River, Willow Creek, and Porcupine Hills Formations. Between the Little

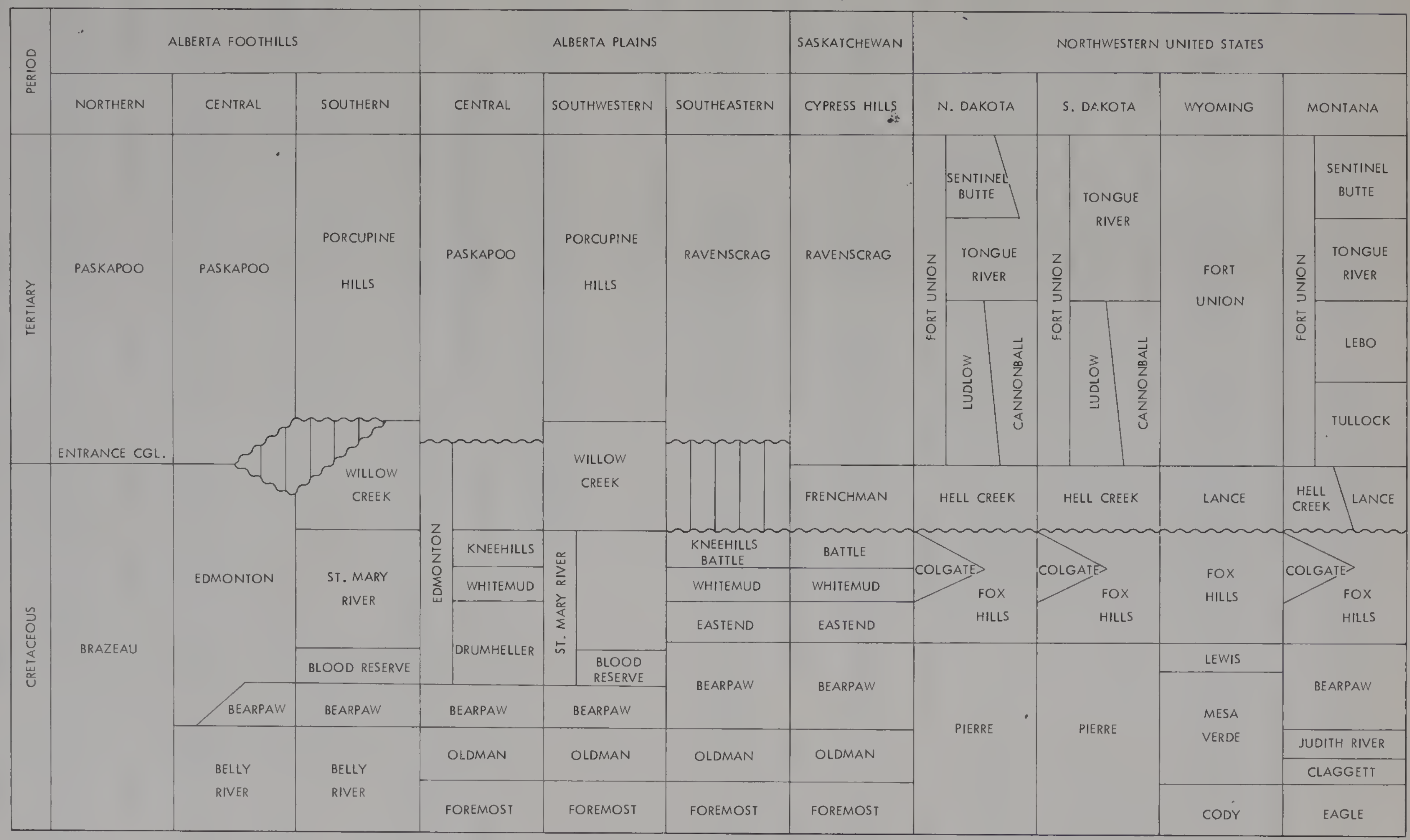

TABLE 1. Chart Showing Correlation of Late Cretaceous and Tertiary Strata of Central and Southwestern Alberta with Those of Southwestern Saskatchewan and Northern United States.

Bow and Pembina Rivers on the east side of the syncline, the Edmonton and Paskapoo Formations overlie the Bearpaw. In southern Saskatchewan the Bearpaw Formation is overlain by the transitional Eastend Formation and the nonmarine Whitemud, Battle, Frenchman, and Ravenscrag Formations.

Age designations for the stratigraphic units near the Cretaceous-Tertiary boundary have been assigned by numerous workers who have attempted to correlate with equivalent strata in northern United States on the basis of associated plant megafossils, vertebrates, marine invertebrates, and nonmarine invertebrates. The general description, distribution and assigned ages of these units are given in Table 2.

Description of Formations Sampled

Edmonton Formation: Edmonton series was the name used by Selwyn (1874) to describe exposures along the North Saskatchewan River in the vicinity of Edmonton. Tyrrell (1887) defined all the beds lying between the upper contact with the Bearpaw shale and the thick coal seam mined at Ardley, Alberta, as part of the Edmonton series. The formal name Edmonton Formation was first used by Allan and Sanderson (1945). In the Red Deer River area, Ower (1960) has divided the Edmonton Formation into five easily recognized Members

UNIT		EDMONTON FORMATION (Tyrrell, 1887)	PASKAPOO FORMATION (Tyrrell, 1887)	PORCUPINE HILLS FORMATION (Dawson, 1883)	WILLOW CREEK FORMATION (Dawson, 1883)	RAVENSCRAG FORMATION (Davis, 1918)	FRENCHMAN FORMATION (Furnival, 1946)
LITHOLOGY		Thin beds of soft, grey, bentonitic sandstone, siltstone, carbonaceous shale, and coal; scattered red to brownish concretionary and nodular intervals; few hard, calcareous and sideritic sandstone intervals.	Hard, buff-weathered, light grey, fine- to coarse-grained, lenticular, crossbedded sandstones alternating with bluish- and greenish-grey silty claystones; interstratified with limestone concretions; numerous coal and lignite beds in basal part.	Thick, buff-weathered, grey, cross-bedded sandstones alternating with grey, silty claystones.	Soft, grey, sandstones interbedded with maroon to reddish-black claystones in lower half; buff-weathering, crossbedded sandstones and grey claystones in upper half.	Grey- to buff-weathered, greyish-brown claystones and silty claystones interbedded with soft, grey, buff-weathered sandstones; numerous lignite seams.	Greenish-brown to brown, fine- to coarse-grained, crossbedded, carbonaceous sandstone; scattered concretions, siltstone pebbles, and limonitic lenses.
DISTRIBUTION		Plains and Foothills of central and southwestern Alberta.	Plains and Foothills of central and southwestern Alberta.	Western margin of the Plains in southwestern Alberta.	Plains and Foothills of southwestern Alberta and adjacent Montana.	Cypress Hills of southeastern Alberta and southwestern Saskatchewan.	Cypress Hills of southeastern Alberta and southwestern Saskatchewan.
THICKNESS		400 feet on Little Bow River in southern Alberta to approximately 1,200 feet on North Saskatchewan River in central Alberta.	200 to 800 feet in the central Plains and up to 5,000 feet in the central Foothills.	Up to 4,000 feet in the Porcupine Hills of southwestern Alberta.	400 feet in the Plains thickening westward to 4,000 feet in the southern foothills.	227 feet (maximum).	Minimum of 10 feet, Ravenscrag Butte, Saskatchewan, thickening westward to a maximum of 225 feet, Elkwater, Alberta.
BOUNDARIES		Upper contact: erosional discon-formity with Paskapoo Formation although locally conformable with overlying channel sandstones. Lower Contact: transitional with Bearpaw Formation.	Upper contact: erosional. Lower contact: unconformable to locally conformable with Edmonton Formation.	Upper contact: erosional. Lower contact: transitional with Willow Creek Formation along southern limit and unconformable along northern limit.	Upper contact: transitional to unconformable with Porcupine Hills Formation. Lower contact: conformable to transitional with St. Mary River Formation.	Upper contact: unconformable with Cypress Hills Formation. Lower contact: transitional with the Frenchman Formation.	Upper contact: transitional with Ravenscrag Formation. Lower contact: unconformable with Battle Formation.
AGE	PLANT MEGAFOSSILS	Maestrichtian (Lance equivalent), (Bell, 1949).	Paleocene (Fort Union equivalent), (Bell, 1949).	Paleocene, (Bell, 1949).	Paleocene (upper half), (Bell, 1949).	Paleocene (Paskapoo equivalent), (Berry, 1935; Bell, 1949).	
	VERTEBRATES	Maestrichtian (Lance equivalent), (Sternberg, 1947).	Paleocene (Fort Union equivalent), (Simpson, 1927; Russell, 1926).				Maestrichtian (Lance equivalent), (Rose, 1916; Sternberg, 1924).
	MARINE INVERTEBRATES	Maestrichtian (Drumheller marine tongue), (Allen and Sanderson, 1945).					
	NONMARINE INVERTEBRATES	Cretaceous, (Tozer, 1956).	Paleocene, (Tozer, 1956).	Paleocene, (Tozer, 1956).	Paleocene (upper half; Fort Union equivalent), (Russell and Landes, 1940; Tozer, 1956).	Paleocene (Paskapoo equivalent), (Russell, 1940).	

UNIT		BATTLE FORMATION (Furnival, 1946)	WHITEMUD FORMATION (Davis, 1918)	FORT UNION GROUP (Meek and Hayden, 1862)	LANCE FORMATION (Hatcher, 1903)	HELL CREEK FORMATION (Brown, 1907)
LITHOLOGY		Dark brown to black and greenish-grey, bentonitic claystones; silicified tuff interval commonly present.	White-weathering, kaolinitic sandstones, siltstones, and clay-stones.	Light grey to yellowish-grey claystones and sandstones; numerous beds of coal and carbonaceous shale.	Light grey to light yellowish-grey fine- to medium-grained crossbedded sandstones; shaly towards base; lenticular stringers and partings of brown carbonaceous shale throughout (Mapel, 1959).	Dark grown to grey, fine- to medium-grained sandstones inter-bedded with brown to black lignitic shales; sandstones with calcareous to bentonitic matrix, and cross-bedded; few brown limonitic concretionary intervals.
DISTRIBUTION		Cypress Hills of southeastern Alberta and southwestern Saskatchewan.	Cypress Hills of southeastern Alberta and southwestern Saskatchewan.	Wyoming, Montana, North and South Dakota.	Eastern Wyoming and Montana.	Montana, southwestern North Dakota, and northern South Dakota.
THICKNESS		5 to 30 feet.	5 to 75 feet.	Approximately 2000 feet (average).	600 to 1200 feet.	100 to 425 feet.
BOUNDARIES		Upper contact: unconformable with Frenchman Formation. Lower contact: conformable with Whitemud Formation.	Upper contact: unconformable with Frenchman Formation; conformable with Battle Formation. Lower contact: transitional with Eastend Formation.	Upper contact: erosional. Lower contact, Ludlow Formation: conformable with Hell Creek and Lance Formations; Cannonball Formation: unconformable with Hell Creek Formation.	Upper contact: conformable with Fort Union Group. Lower contact: conformable with Fox Hills Formation.	Upper contact: conformable with Fort Union Group. Lower contact: conformable with Fox Hills Formation.
AGE	PLANT MEGAFOSSILS			Paleocene, (Knowlton, 1919; Dorf, 1940; Brown, 1948, Bell, 1954).	Cretaceous, (Dorf, 1940).	
	VERTEBRATES			Paleocene, (Jepsen, 1930; Simpson, 1937; Brown, 1948).	Cretaceous, (Hose, 1955; Sternberg, 1947).	Cretaceous, (Leonard, 1911; Thom and Dobbin, 1924).
	MARINE INVERTEBRATES			Paleocene (Cannonball Formation), (Stanton, 1920; Dorf, 1940; Schuchert and Dunbar, 1941; Fox and Ross, 1942).		
	NONMARINE INVERTEBRATES			Paleocene, (Russell, 1932; Brown, 1948).	Cretaceous, (Henderson, 1935).	Cretaceous (Meek and Hayden, 1864; Whitefield, 1903, 1907; Henderson, 1935).

TABLE 2. Summary of Lithology, Distribution and Age of Formations Adjacent the Cretaceous-Tertiary Boundary in Central and Southwestern Alberta, Southwestern Saskatchewan and Northern United States.

(A to E). Member A is 420 to 900 feet thick and is separated from the underlying Bearpaw shales by a basal transitional sand. The interval is characterized by a large number of coal seams interbedded with bentonitic shales and sandstones. Member B is 200 to 300 feet thick and barren of coal. It consists mainly of pale green claystones and siltstones interbedded with a few fine-grained sandstones. A thin marine tongue (Drumheller marine tongue) of fossiliferous limestone is almost always present. Member B contains most of the dinosaur remains found in the Formation. Member C contains 70 to 180 feet of interbedded coal, bentonitic grey shales and grey coarse-grained sandstones. Member D is 20 to 60 feet in thickness and composed of two parts. The upper part consists of brown bentonitic claystone with a mauve-weathering surface. It almost always contains a light grey siliceous bed about one foot thick, referred to as the Kneehills Tuff. The upper part grades into a white kaolinitic claystone, sandstone or siltstone. Member D is overlain by a sequence of greenish-grey bentonitic claystones and a few coarse-grained sandstones interbedded with thick coal seams. This interval constitutes Ower's Member E and averages about 200 feet in thickness.

Figure 2 shows the sample locations and generalized lithology of the sections sampled in the main study area

(see appendix for detailed lithologic descriptions). In R.C.A. No. 65-1 Core (section I, figure 2) Members C, D, and E of Ower's subdivision are present. Member C is 75 feet thick with numerous carbonaceous to coaly layers, and Member D contains 65 feet of kaolinitic sandstone and 45 feet of the "Mauve Shale" with a well developed silicified tuff layer (Whitemud and Battle equivalents, Table 1). Member E passes from 45 feet of dull grey claystones and a few minor sandstones to 135 feet of well developed coal layers interbedded with carbonaceous claystones, siltstones and sandstones. Sections II, III and IV (figure 2) on the Red Deer River were measured and sampled from the "Mauve Shale" upward. With the exception of the uppermost buff-weathered sandstone units, sections II and IV were described by Ower as characteristic of Member E. Section III is also within Member E, but lacks coal and is lithologically similar to the lower 45 feet of the Member in section I and the lower 120 feet in section IV.

<u>Paskapoo Formation:</u> The Paskapoo Formation was named by Tyrrell (1887) from exposures between the mouth of the Blindman River and Ardley. In the Red Deer River Valley, other than the type-section, the Paskapoo Formation is defined by most geologists as any thick-bedded, buff-weathered sandstone overlying the uppermost coaly interval (Member E)

of the Edmonton Formation. A portion of the Paskapoo was measured and sampled from sections I, II, and IV. In section I (figure 2) the lower boundary was placed at the top of the uppermost coal seam. This is approximately 60 feet lower than the contact elevation of 2,620 feet mapped in the general area by Rutherford (1939). It was found, however, that the 35 feet of light grey, medium-grained sandstone immediately overlying the uppermost coal seam was indistinguishable in hand-specimen from the sands of the Paskapoo type-section. From this lower sandstone interval the Paskapoo grades upward into 90 feet of interbedded grey to yellowish-grey carbonaceous siltstones, claystones, and silty-claystones.

Along the Red Deer River, the Formation was sampled from sections I and IV (figure 2). In both areas it varies from 10 to 40 feet in thickness and consists of fine- to coarse-grained buff-weathered sandstone.

Willow Creek Formation: Composite sections of the Willow Creek Formation were measured and sampled in three different areas of southern Alberta (figure 1). Palynological recovery was sufficient to make only limited comparisons with the outcrop sections in the main study area.

On the east side of the Alberta Syncline north of Fort Macleod and along the Oldman River, 195 feet of

interbedded multicolored silty-claystones and thin grey sandstones were sampled. A well developed silicified tuff within a mauve-weathered claystone and underlain by a white fine-grained sandstone occurs at the base of the section. Tozer (1952) originally described this interval, on the basis of lithologic similarities, as equivalent to the Kneehills Tuff, Mauve shale and Whitemud sandstone along the Red Deer River and to the Battle and Whitemud Formations in the Cypress Hills. Tozer assumed the units marked the top of the St. Mary River Formation on the eastern limb of the Alberta Syncline.

On the west side of the Alberta Syncline scattered samples from the entire Willow Creek Formation were taken along the Oldman River north of Pincher Creek. In this area, Douglas (1950) divided the formation into five "zones" on the basis of lithology. In ascending order they are as follows: zone A, greenish-grey to maroon, silty-claystones, and soft grey sandstones, about 540 feet thick; zone B, approximately 250 feet in thickness, and of soft grey sandstones and mottled green to red claystones; zone C of coarse-grained, cross-bedded, conglomeratic, grey sandstone, 15 to 30 feet in thickness; zones D and E together comprise approximately 1,900 feet of strata (Tozer, 1956) and grade from the soft grey sandstones and multicolored claystones

of zone D to the hard ledge forming sandstones of zone E.

West of Granum the upper part of the Willow Creek Formation was measured and sampled. Here Williams and Dyer (1930) and Russell (1932) reported a nonmarine invertebrate fauna very similar to the Paskapoo and Fort Union faunas. In the same section Bell (1949) correlated a conglomeratic sandstone with the conglomerate which marks the base of the Paskapoo on the Little Bow River. He proposed, therefore, a stratigraphic subdivision of the Willow Creek into upper and lower units. Tozer (1956) states that the conglomerate probably marks the Cretaceous-Tertiary boundary because Paleocene molluscs have not been found below this horizon.

CHAPTER FOUR - STRATIGRAPHIC PALYNOLOGY

Regional Palynological Correlations

Palynological elements are used to calibrate a standard section represented by the core from R.C.A. No. 65-1 boring (section I) containing the Cretaceous-Tertiary boundary and to make lateral correlations with outcrop sections along the Red Deer River.

Samples from R.C.A. No. 65-1 Core were examined, and 305 microfloral entities were coded and plotted according to first appearances. Figure 3 shows the number and percentage of entities restricted to different intervals in the section. Two distinct microfloral changes are apparent; one occurring in the Edmonton Formation at the base of the upper coaly interval and the other in the Paskapoo Formation at approximately 90 feet in depth in the R.C.A. No. 65-1 boring. With the exception of long-ranging forms, all morphological entities (coded) were closely examined for stratigraphic significance. Twenty-six such stratigraphically significant named species known to be characteristic of Tertiary or uppermost Cretaceous beds elsewhere were delineated. Above the base of the upper coaly interval, twelve species were recognized which have previously been recorded as

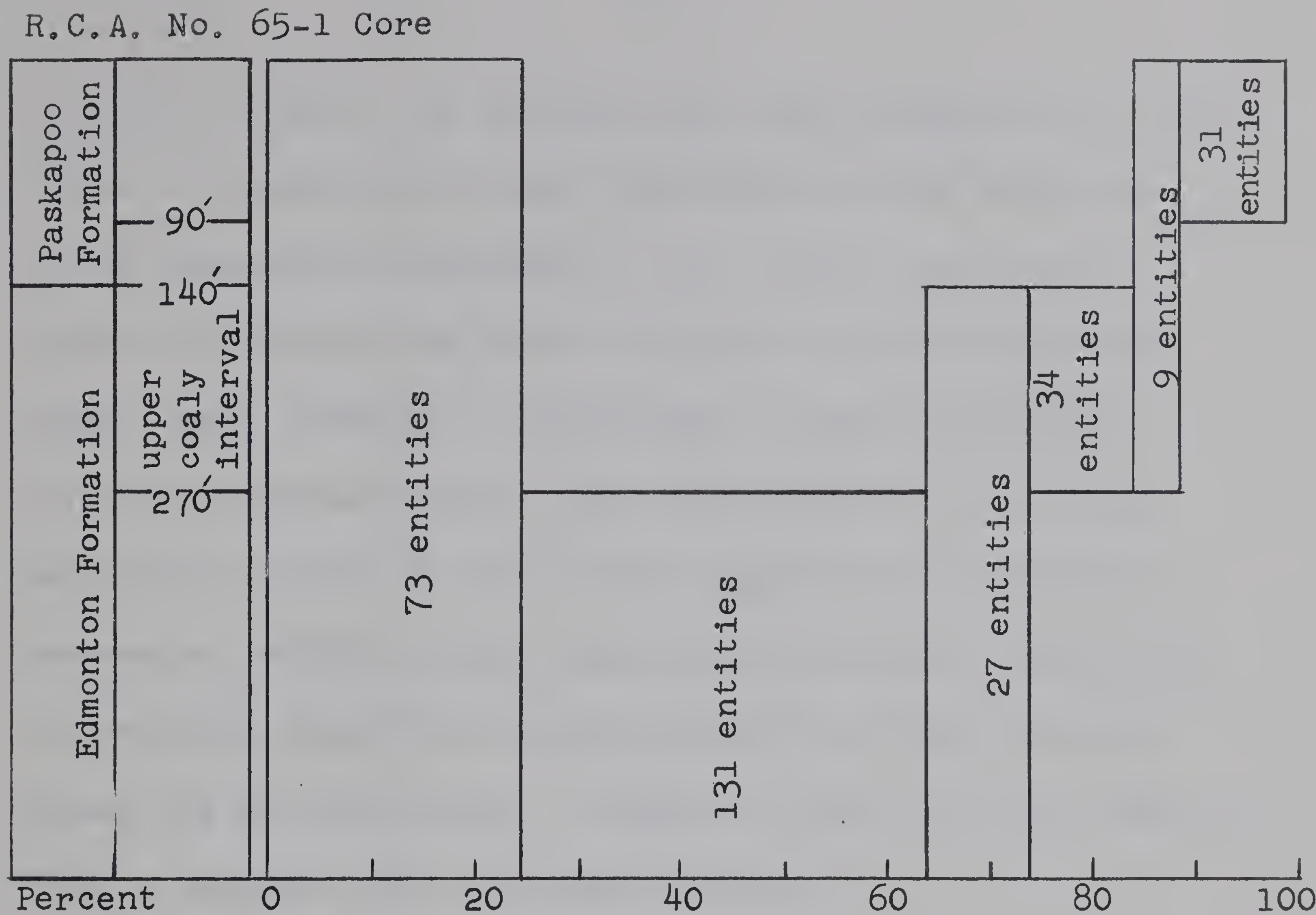

FIGURE 3. Relative Number and Percentage of Entities Restricted to Various Intervals in Section I.

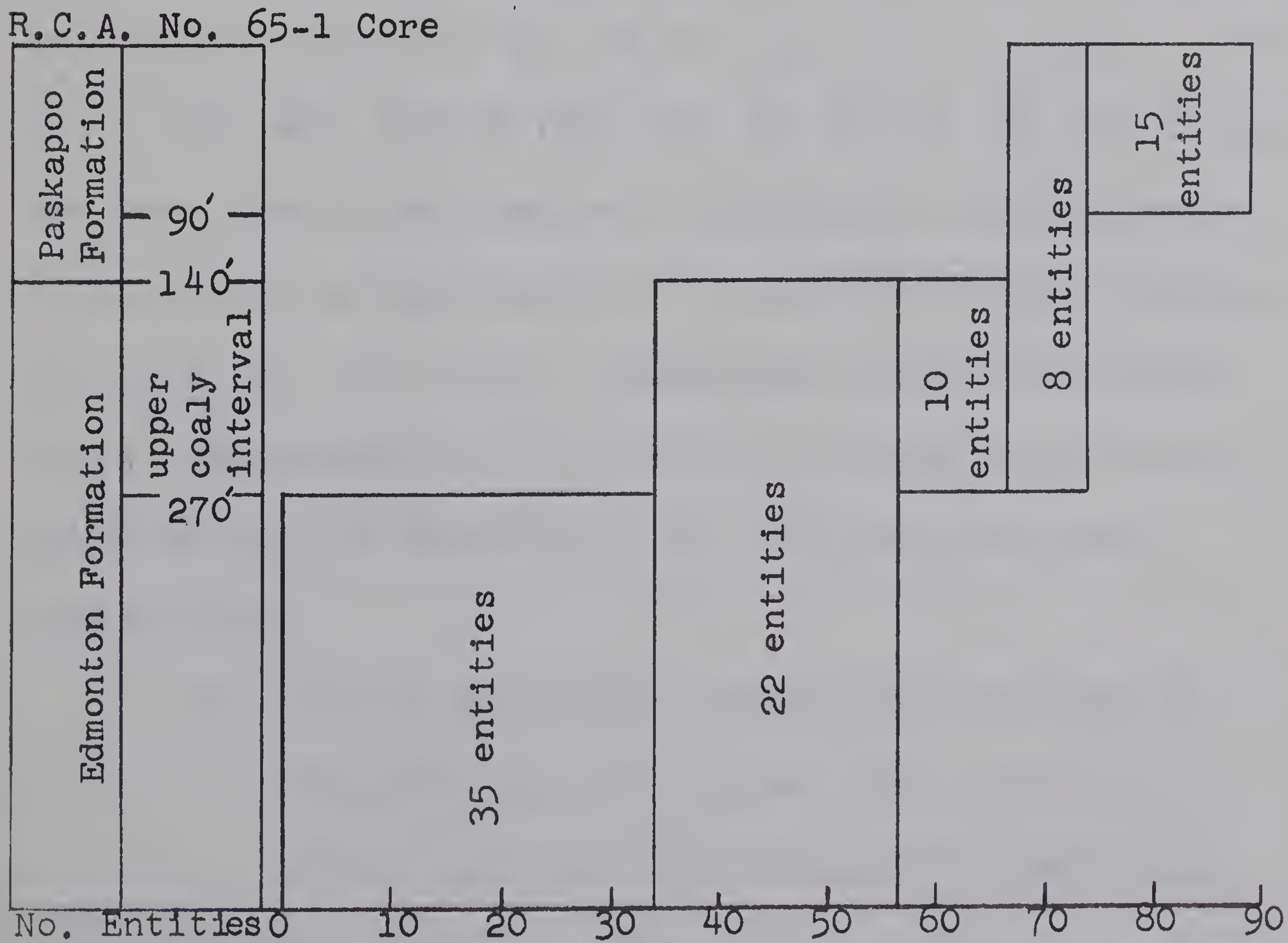

FIGURE 4. Number of Quantitatively Important Entities Restricted to Various Intervals in Section I.

Tertiary in age. Two species were also recognized at this level as common in Tertiary and Maestrichtian strata in other geographic localities. Also, twelve species of latest Cretaceous age were identified in beds below the upper coaly interval. In addition, those morphologic entities representing at least one percent of the total microfloral count in one or more samples were plotted to determine reliable marker species sufficiently restricted in vertical range for correlation with outcrop sections along the Red Deer River. Figure 4 shows the broad results from a detailed plot of these entities.

The microspore and pollen in samples from outcrop sections II (Sec. 17, Tp. 38, R. 23, W4), III (Sec. 17, Tp. 36, R. 21, W4), and IV (Sec. 13, Tp. 34, R. 22, W4) on the Red Deer River were examined utilizing the same system of codification as was employed in describing those contained in R.C.A. No. 65-1 Core. Comparisons between the microfloral assemblages in the study area reveal very distinct correlations and demonstrate the following pertinent similarities:

(1) Of the 35 abundant morphologic entities restricted below the upper coaly interval in R.C.A. No. 65-1 Core (figure 4), twenty-one

were found common in samples from section III, and only four were recorded in samples from sections II and IV.

(2) Of the twelve uppermost Cretaceous species found restricted below the upper coaly interval in R.C.A. No. 65-1 Core, seven are contained in the beds of section III and none was noted in samples from sections II and IV.

(3) Of the twenty-two abundant morphologic entities confined to the Edmonton Formation in R.C.A. No. 65-1 Core (figure 4), nine occur in beds of section III and ten are present in beds of sections II and IV.

(4) Of the ten abundant morphologic entities restricted to the upper coaly interval in R.C.A. No. 65-1 Core (figure 4), seven are described in beds from sections II and IV and none was recognized in samples from section III.

(5) Of the eight abundant morphologic entities which range from the upper coaly interval to the Paskapoo Formation in R.C.A. No. 65-1 Core (figure 4), three were found abundant in the beds of sections II and IV and none

was recorded from section III.

(6) Of the twelve Tertiary species found restricted above the upper coaly interval in R.C.A. No. 65-1 Core, three were found in samples from sections II and IV and none was recognized in the beds of section III.

(7) Outcrop sections II, III and IV contain the majority of the long-ranging morphologic entities described in R.C.A. No. 65-1 Core.

Microfloral "Zones"

Microfloral elements used in the regional correlations of outcrop sections II, III and IV to R.C.A. No. 65-1 Core, section I, reveal a threefold division in the microfloral spectrum. These microfloral divisions are designated from oldest to youngest as A, B, and C "zones" and are based on species showing vertical and quantitative importance and/or stratigraphic significance.

Microfloral "zone" A is established by the presence of those stratigraphically significant uppermost Cretaceous species listed in Table 3 and by the presence of the quantitatively abundant species common to and restricted within the beds of section III and the beds below the upper coaly horizon of section I (Tables 4 and 5).

SPECIES	ALBERTA			BRITISH COLUMBIA		MONTANA	WYOMING		NEW MEXICO		SOUTH DAKOTA		SIBERIA		COLORADO	MARYLAND	GERMANY	SCOTLAND	AUSTRALIA
	Microfloral "zones"			Uppermost Cretaceous	Tertiary	Maestrichtian	Maestrichtian	Paleocene	Uppermost Cretaceous	Paleocene	Maestrichtian	Paleocene	Maestrichtian	Paleocene	Tertiary	Paleocene	Tertiary	Tertiary	Tertiary
	A	B	C																
Aquilapollenites polaris	X						Funkhouser (1961)						Bratzeva (1967)						
Aquilapollenites reticulatus	X										Stanley (1961)								
Leptolepidites tenuis	X										Stanley (1961)								
Schizosporis complexus	X										Stanley (1961)								
Aquilapollenites amplus	X										Stanley (1961)								
Aquilapollenites reductus	X					Norton (1965)													
Aquilapollenites sp. cf. A. attenuatus	X						Funkhouser (1961)												
Aquilapollenites conatus	X					Norton (1965)													
Aquilapollenites delicatus	X										Stanley (1961)								
Kurtzipites trispissatus	X								Anderson (1960)										
Momipites sanjuanensis	X								Anderson (1960)										
Wodehousia spinata	X					Norton and Hall (1967)					Stanley (1961)		Bratzeva (1967)						
Ulmoideipites tricostatus		X	X						Anderson (1960)	Anderson (1960)				Samoilovich (1967)	Newman (1964)				
Alnus verus			X	Rouse (1962)	Rouse (1962)										Wodehouse (1933)		Potonie (1934) Thomson and Pflug (1953)		
Alnus trina		X	X									Stanley (1965)							
Momipites tenuipolus		X	X							Anderson (1960)									
Momipites inaequalis		X	X							Anderson (1960)					Newman (1964)				
Tilia danei		X	X							Anderson (1960)									
Aquilapollenites spinulosus			X					Funkhouser (1961)							Funkhouser (1961)				
Caryapollenites scabratus			X									Stanley (1965)				Groot and Groot (1962)			
Tilia tetraforaminipites			X		Rouse (1962)										Wodehouse (1933)				
Vitis sp. cf. V. affluens			X									Stanley (1965)							
Alnus rubriformis			X															Simpson (1961)	
Carpinus subtriangula			X									Stanley (1965)							
Ovoidites ligneolus			X									Stanley (1965)					Potonie (1931)		Harris (1965)
Pandanus ? sp. cf. P? shiabensis			X															Simpson (1961)	

TABLE 3. Stratigraphically Significant Species at the Cretaceous-Tertiary Boundary and Their Distribution in Other Localities.

The microfloral species thought to be characteristic of "zone" B are listed in Tables 4, 6 and 7. The "zone" is recognized by the existence of the quantitatively abundant forms restricted to the upper coaly interval in section I and likewise confined within the beds of outcrop sections II and IV. "Zone" B is also characterized by the presence of four species of Tertiary age and by the absence of the species recorded as Late Cretaceous in age (Table 3).

Microfloral "zone" C is present only in the Paskapoo Formation of section I, and is represented by the twelve species of Tertiary age listed in Tables 3 and 4.

Megaspore Occurrences

Megaspores were recovered in large quantities in samples from most of the geologic sections. Only two genera, however, were found present; Balmeisporites and Azolla.

In the main study area, genus Balmeisporites is represented by five species and confined to microfloral "zone" A (Tables 4 and 5). Three of the species were also recorded in samples taken from outcrops of the uppermost St. Mary River Formation along the Oldman River north of Fort Macleod (figure 1). To date, this genus has not been

AGE	FORMATION	MEMBER (OWER, 1960)	FLORAL "ZONES"	DEPTH IN FEET	Laevigatosporites gracilis	Sequoiapollenites paleocenicus	Taxodiaceaepollenites hiatus	Azolla distincta**	Azolla schopfi**	Aquilapollenites polaris*	Aquilapollenites reticulatus*	Leptolepidites tenuis*	Erdtmanipollis pachysandroides	Schizosporis complexus*	Salixipollenites sp. cf. Tricolpites bathyreticulatus	Aquilapollenites amplus*	Aquilapollenites reductus*	Azolla conspicua**	Balmeisporites striatellus**	Equisetosporites amabilis	Sigmopollis hispidus	Symplocoipollenites vestibulum	Aquilapollenites sp. cf. A. attenuatus*	Aquilapollenites sp. C	Hamulatisporis hamulatis	Aquilapollenites sp. A	Aquilapollenites sp. B	Balmeisporites sp. A**	Balmeisporites sp. B**	Balmeisporites sp. C**	Balmeisporites sp. D**	Dictyophyllidites sp. A	Aquilapollenites conatus*	Aquilapollenites delicatus*	Azolla barbata**	Kurtzipites trispissatus*	Momipites sanjuanensis*	Wodehousia spinata*	Aquilapollenites sp. cf. A. quadricretaceus	Azolla filosa**	Azolla pilata**	Cingulatisporites dakotaensis	Cranwellia rumseyensis	Cupuliferoipollenites pusillus	Polypodiisporites sp.	Scollardia steevesi	Sphagnum regium	Reticuloidosporites sp.	Tricolpites sp. A	Tricolpites sp. B	Azolla lauta**	Kurtzipites sp.	Myrtaceidites sp. C	Rhoipites sp. cf. R. pipinnus	Betulaceoipollenites sp.	Myrtaceidites sp. A	Liliacidites sp.	Myrtaceidites sp. B	Salixipollenites sp. B	Salixipollenites sp. A	Ulmoideipites tricostatus*	Alnus trina*	Alnus verus*	Aquilapollenites spinulosus*	Azolla bulbosa**	Caryapollenites scabratus*	Momipites inaequalis*	Tilia tetraforaminipites*	Vitis sp. cf. V? affluens*	Alnus rubriformis*	Carpinus subtriangula*	Momipites tenuipolus*	Ovoidites ligneolus*	Pandanus ? sp. cf. P? shiabensis*	Tilia danei*
TERTIARY	PASKAPOO		C	16 - 21	☼		✦																																																o		o	o	o		o	✦			✦		✦	o		o
				45 - 50	☼		✦																																															✦			o	o		o							o	✦	
				54 - 60	☼		✦	o	o																																																	o	o	✦	o	✦	o		o	✦	✦	✦		
				63 - 66																																																				✦	✦			o		o			✦						
				80 - 87	☼	✦	☼	o																																																o	✦		o	☼	☼	o	✦	o							
	EDMONTON		B	142 - 146	●	✦	●	✦	✦																																o		o											o	o		o	o	✦															
				150 - 156	☼	✦	●																																										o			o						o																
				163 - 172	☼	✦	●	☼	☼																																															o																			
				175 - 181	☼	o	●	✦	☼																																		o				✦						o	✦			✦																	
				198 - 202	☼	✦	●	●	☼																																					o				✦	o			✦	✦	✦			✦															
				221 - 227	☼	✦	●																																		o	✦		o	o		✦			☼			o	✦							o													
CRETACEOUS		E		229 - 232	☼	✦	●	o	●																																	✦			o						✦	o		o		o																		
				264 - 268	✦	✦	●																																o			o				✦	o					o	o					✦	o														
		D	A	276 - 280	✦		✦						o													o												o														✦	o	o																					
				286 - 291	✦	✦	☼		o		o			o	o		✦		✦		✦			o			o				o		o	✦	✦		o	✦	✦	✦	✦						o		✦	✦	●																								
				304 - 308	✦	✦	☼	o					o											o								o	o			✦	o																																						
				313 - 319	✦	✦	☼	✦		o	o					✦	✦		✦			✦		o			✦						o	o	o	✦	o	✦					✦	o		✦		✦	✦	☼	✦																								
				327 - 335	✦	o	☼				o																																							o																									
		C		431 - 435	●	✦	☼	✦	☼		o		o				✦						o		✦			o														o	✦		o	✦	✦				✦	o																							
				445 - 449	●	✦	☼			o	o	o	✦	✦	o	✦	✦		o			✦		o	✦	✦	o	✦	o	o	o	o											✦	o	o	o	✦		✦	o																									
				454 - 459	●	✦	☼			o	o	o	✦				o			o			✦	o	o																			o			✦	✦																											
				476 - 481	●	✦	☼			o	o		o		o	o	o	✦	✦	✦	o	✦																										✦	✦																										
				502 - 505	●	☼	●			o	o	o	o	o	o																											o	✦	o	o	o	✦																												

Long-ranging species (Laevigatosporites gracilis – Azolla schopfi); Species restricted to "zone" A (Aquilapollenites polaris – Azolla pilata); Species restricted to "zones" A and B (Cingulatisporites dakotaensis – Kurtzipites sp.); Species restricted to "zone" B (Myrtaceidites sp. C – Salixipollenites sp. B); Species restricted to "zones" B and C (Salixipollenites sp. A – Alnus trina); Species restricted to "zone" C (Alnus verus – Tilia danei)

LEGEND

	POLLEN AND MICROSPORES	MEGASPORES
o Rare	1 to 2 per cent	1 to 3 grains
✦ Common	3 to 6 per cent	4 to 10 grains
☼ Abundant	7 to 20 per cent	10 to 30 grains
● Dominant	greater than 20 per cent	greater than 30 grains

* Index species
** Megaspores

TABLE 4. Distribution and Relative Abundances of Microfloral Species in R.C.A. No. 65-1 Core, Section 1.

	Species	1 – 2	30 – 32	58 – 60	83 – 88	94 – 96	101 – 103	112 – 115
MAUVE SHALE	AGE	CRETACEOUS						
	FORMATION	EDMONTON						
	MEMBER (OWER, 1960)	E						
	FLORAL "ZONE"	A						
	INTERVAL ABOVE MAUVE SHALE (in feet)	1 – 2	30 – 32	58 – 60	83 – 88	94 – 96	101 – 103	112 – 115
Long-ranging species	Laevigatosporites gracilis	⌖	o	⌖	o	⌖	o	☼
	Sequoipollenites paleocenicus	⌖	⌖	☼	o	o	⌖	⌖
	Taxadiaceaepollenites hiatus	☼	☼	☼	☼	☼	☼	☼
	Azolla distincta**			⌖	o		o	o
	Azolla schopfi**			☼				o
Species restricted to "zone" A	Leptalepidites tenuis*					o		o
	Erdtmanipollis pachysandroides		o	⌖				
	Salixipollenites sp. cf. Tricolpites bathyreticulatus				o	⌖		o
	Aquilapollenites amplus*			o	o		o	
	Aquilapollenites reductus*		o		⌖	o		
	Balmeisporites striatellus**		o	o				
	Equisetosporites amabilis					o	o	
	Sigmopollis hispidus					o		o
	Symplocoipollenites vestibulum		o	o				
	Aquilapollenites sp. C			o	o		o	o
	Hamulatisporis hamulatis					⌖		
	Balmeisporites sp. D**			o				
	Dictyophyllidites sp.		o					
	Aquilapollenites conatus*		o	o		o		o
	Azalla barbata**			o				
	Kurtzipites trispissatus*							⌖
	Momipites sanjuanensis*				o		o	
	Wodehousia spinata*		o	o	o		o	o
	Aquilapollenites quadricretaceus			o				o
	Azolla filosa*			o				
Species restricted to "zones" A and B	Cinqulatisporites dakotaensis		o	⌖	o			
	Cranwellia rumseyensis		o			o	o	o
	Cupuliferoipollenites pusillus		o					o
	Polypodiisporites sp.			o		o		o
	Scollardia steevesi		o	o		o	o	
	Sphagnum regium			o			o	
	Reticuloidosporites sp.			⌖	⌖		o	
	Tricolpites sp. A		o	o	o	o	o	o
	Tricolpites sp. B		⌖	⌖	⌖	o	o	o
	Azolla lauta**		⌖	⌖			⌖	⌖

TABLE 5. Distribution and Relative Abundances of Microfloral species in Outcrop Section III (see Table 4 for legend).

AGE		CRETACEOUS							TERTIARY
FORMATION		EDMONTON							
MEMBER (OWER, 1960)		MAUVE SHALE / E							
FLORAL "ZONE"		B							
APPROXIMATE INTERVAL ABOVE MAUVE SHALE (in feet)		82 - 87	102 - 108	126 - 130	140 - 142	145 - 147	163 - 165	165 - 171	
Long-ranging species	Laevigatosporites gracilis	☼	o	☼		⌖		⌖	
	Sequoiapollenites paleocenicus	⌖	⌖	⌖		⌖		⌖	
	Taxodiaceaepollenites hiatus	o	⌖	●		●		●	o
	Azolla distincta**		⌖	⌖	⌖	⌖	⌖		
	Azolla schopfi**		⌖	⌖	⌖	⌖	⌖		
Species restricted to "zones" A and B	Cingulatisporites dakotaensis					o			
	Cranwellia rumseyensis	o	o						
	Cupuliferoipollenites pusillus		o	o					
	Polypodiisporites sp.	o						o	
	Scollardia steevesi	o	⌖						
	Sphagnum regium	o							
	Reticuloidosporites sp.			o					
	Tricolpites sp. A	o						o	
	Tricolpites sp. B			o		o			
	Azolla lauta**			o					
	Kurtzipites sp.			⌖		o			
Species restricted to "zone" B	Azolla fistulosa**							⌖	
	Myrtaceidites sp. C	o	o			o			
	Rhoipites sp. cf. R. pisinnus	o	o						
	Betulaceoipollenites sp.		o	o		o		o	
	Myrtaceidites sp. A	o	o						
	Liliacidites sp. A	o		o					
	Myrtaceidites sp. B			o					
	Salixipollenites sp. B		⌖					o	
Species restricted to "zones" B and C	Salixipollenites sp. A		o	o		o			
	Ulmoideipites tricostatus*			o		o			
Species restricted to "zone" A	Momipites inaequalis*		⌖			o			
	Momipites tenuipolis*							o	
	Tilia danei*			o				⌖	

TABLE 6. Distribution and Relative Abundances of Microfloral Species in Outcrop Section II (see Table 4 for legend).

MAUVE SHALE

CRETACEOUS				TERTIARY	AGE
EDMONTON				PASKAPOO	FORMATION
E					MEMBER (OWER, 1960)
no somple yield	B				FLORAL "ZONE"
	150 - 155	170 - 175	200 - 205		INTERVAL ABOVE MAUVE SHALE (in feet)
Long-ronging species	☼	⌖	o		Loevigotosporites gracilis
	⌖	⌖	☼		Sequoiopollenites poleocenicus
	●	●	●		Toxodiaceoepollenites hiotus
	⌖				Azolla distincto**
Species restricted to "zones" A ond B		o			Cingulotisporites dokotoensis
	o				Cronwellio rumseyensis
	⌖	⌖	o		Cupuliferoipollenites pusillus
		o			Polypodiisporites sp.
	o	o	o		Scollordia steevesi
	o		o		Sphognum regium
	⌖				Reticuloidosporites sp.
	⌖	⌖	o		Tricolpites sp. A
	o	⌖	o		Tricolpites sp. B
		o			Kurtzipites sp.
Species restricted to "zone" B	o				Azollo fistuloso**
	⌖	⌖	o		Betulaceoipollenites sp.
	o	o	o		Liliacidites sp.
		o	o		Myrtoceidites sp. B
	⌖	⌖	⌖		Solixipollenites sp. B
Species restricted to "zones" B ond C	o	⌖	o		Solixipollenites sp. A
	o		o		Momipites inoequolis*

TABLE 7. Distribution and Relative Abundances of Microfloral Species in Outcrop Section IV (see Table 4 for legend).

reported from beds younger than latest Cretaceous age.

Azolla megaspores were found abundant in every geologic section sampled in central and southwestern Alberta. Nine species were recorded, eight of which are new and classified according to the approach proposed in Chapter Five. Because this method of classification can be used to identify species from mere fragments of the perispore wall, it may prove to be of greater utility in establishing identifications than systems based mainly on the nature of the "swimming apparatus".

Although many of the Azolla megaspore species were found to possess considerable lateral variations, they were of little assistance in accomplishing the objectives set forth in the study. A detailed investigation of these forms in central and southwestern Alberta would constitute a completely separate study.

Species Restricted to Microfloral "Zone" A

Aquilapollenites polaris Funkhouser: Lance Formation (Maestrichtian), Wyoming, Funkhouser (1961); Maestrichtian, Sibera, U.S.S.R., Bratzeva (1967).*

Aquilapollenites reticulatus Stanley; Hell Creek Formation (Maestrichtian), South Dakota, Stanley (1961).*

Leptolepidites tenuis Stanley; Hell Creek Formation (Maestrichtian), South Dakota, Stanley (1965).* **

Erdtmanipollis pachysandroides Krutzsch* **

Schizosporis complexus Stanley; Hell Creek Formation (Maestrichtian), South Dakota, Stanley, 1965.*

Salixipollenites sp. cf. Tricolpites bathyreticulatus Stanley* **

Aquilapollenites amplus Stanley; Hell Creek Formation (Maestrichtian), South Dakota, Stanley (1965).* **

Aquilapollenites reductus Norton; Hell Creek Formation (Maestrichtian), Montana, Norton (1965).* **

Azolla conspicua n. sp.*

Balmeisporites striatellus Kondinskaya* **

Equisetosporites amabilis Srivastava* **

Sigmopollis hispidus Hedlund* **

Symplocoipollenites vestibulum (Potonié) Potonié* **

Aquilapollenites sp. cf. A. attenuatus Funkhouser; Lance Formation (Maestrichtian), Wyoming, Funkhouser (1961).*

Aquilapollenites sp. C* **

Hamulatisporis hamulatis Krutzsch* **

Aquilapollenites sp. A*

Aquilapollenites sp. B*

Balmeisporites sp. A*

Balmeisporites sp. B*

Balmeisporites sp. C*

Balmeisporites sp. D* **

Dictyophyllidites sp.* **

Aquilapollenites conatus Norton; Hell Creek Formation (Maestrichtian), Montana, Norton (1965).* **

Aquilapollenites delicatus Stanley; Hell Creek Formation (Maestrichtian), South Dakota, Stanley (1961).*

Azolla barbata n. sp.* **

Kurtzipites trispissatus Anderson; Kirkland shale (uppermost Cretaceous), San Juan Basin, New Mexico, Anderson (1960).* **

Momipites sanjuanensis Anderson; Lewis shale (uppermost Cretaceous), San Juan Basin, New Mexico, Anderson (1960).* **

Wodehousia spinata Stanley: Hell Creek Formation (Maestrichtian), South Dakota, Stanley (1961); Hell Creek Formation (Maestrichtian), Montana Norton and Hall (1967); Maestrichtian, Siberia, U.S.S.R., Bratzeva (1967).* **

Aquilapollenites sp. cf. A. quadricretaceus Chlonova; Maestrichtian to Danian, Vakh-River Basin, U.S.S.R., Chlonova (1961).* **

Azolla filosa n. sp.* **

Azolla pilata n. sp.*

Species Ranging Through Microfloral "Zones" A and B

Cingulatisporites dakotaensis Stanley* ** + ++

Cranwellia rumseyensis Srivastava* ** + ++

Cupuliferoipollenites pusillus (Potonié) Potonié* ** + ++

Polypodiisporites sp.* ** +

Scollardia steevesi Srivastava* ** + ++

Sphagnum regium Drozhastichich* ** + ++

Reticuloidosporites sp.* ** + ++

Tricolpites sp. A* ** + ++

Tricolpites sp. B* ** + ++

Azolla lauta n. sp.* **

Kurtzipites sp.* + ++

Species Restricted to Microfloral "Zone" B

Myrtaceidites sp. C* +

Rhoipites sp. cf. *R. pisinnus* Stanley* +

Betulaceoipollenites sp.* + ++

Myrtaceidites sp. A* +

Liliacidites sp.* + ++

Myrtaceidites sp. B* + ++

Salixipollenites sp. B* + ++

Azolla fistulosa n. sp.+ ++

Species Ranging Through Microfloral "Zones" B and C

Salixipollenites sp. A* + ++

Ulmoideipites tricostatus Anderson: Ojo Alamo sandstone and Nacimiento Formation (uppermost Cretaceous(?) to Lower Paleocene), San Juan Basin, New Mexico, Anderson (1960); Paleocene, northwestern Colorado, Newman (1964); Danian, Siberia, U.S.S.R., Samoilovich (1967).* +

Alnus trina Stanley; Fort Union Formation, Ludlow Member (Paleocene), South Dakota, Stanley (1965).*

Momipites tenuipolis Anderson; Nacimiento Formation (Lower Paleocene), South Dakota, Stanley (1965).*

Momipites inaequalis Anderson: Ojo Alamo sandstone and Nacimiento Formation (lowermost Paleocene), San Juan Basin, New Mexico, Anderson (1960); Paleocene, northwestern Colorado, Newman (1964).* + ++

Tilia danei Anderson; Nacimiento Formation (lowermost Paleocene), San Juan Basin, New Mexico, Anderson (1960).* +

Species Restricted to Microfloral "Zone" C

Alnus verus (Potonié) Rouse: Green River Formation (Eocene), Colorado, Wodehouse (1933); Eocene and

Miocene, Germany, Potonié (1934) and Potonié and Venitz (1934); Upper Tertiary, Germany, Thomson and Pflug (1953); Burrard Formation (Upper Cretaceous to Eocene) British Columbia, Rouse (1962).*

Aquilapollenites spinulosus Funkhouser; Fort Union Formation (Paleocene), Wyoming, Eocene of Rocky Mountain Area, Funkhouser (1961).*

Azolla bulbosa n. sp.*

Caryapollenites scabratus Groot and Groot: Fort Union Formation, Cannonball Member (Paleocene), South Dakota, Stanley (1965); Brightseat Formation (Paleocene), Maryland, Groot and Groot (1962).*

Tilia tetraforaminipites Wodehouse: Green River Formation (Eocene), Colorado, Wodehouse (1933); Burrard Formation, Third Beach (Eocene), British Columbia, Rouse (1962).*

Vitis sp. cf. V? affluens Stanley; Fort Union Formation, Ludlow Member (Paleocene), South Dakota, Stanley (1965).*

Alnus rubriformis Simpson; Interbasaltic lignites (Early Tertiary), Mull district of Argyllshire, western Scotland, Simpson (1961).*

Carpinus subtriangula Stanley; Fort Union Formation, Cannonball Member (Paleocene), South Dakota, Stanley (1965).*

Ovoidites ligneolus (Potonié) Potonié: Tertiary, Brisbane Queensland, Harris (1965); Fort Union Formation, Cannonball Member (Paleocene), South Dakota, Stanley (1965); Oligocene and Miocene, Germany, Potonié (1931).*

Pandanus sp? cf. *P? shiabensis* Simpson; Interbasaltic lignites (Tertiary), Mull district of Argyllshire, western Scotland, Simpson (1961).*

Dominant Species Recorded in Microfloral "Zones" A, B and C

Laevigatosporites gracilis Wilson and Webster* ** + ++

Sequoiapollenites paleocenicus Stanley* ** + ++

Taxodiaceaepollenites hiatus (Potonié) Kremp* ** + ++

Azolla distincta n. sp.* ** + ++

Azolla schopfi Dijkstra* ** +

* in section I

** in section III

\+ in section II

++ in section IV

Summary and Conclusions

Four sections of uppermost Cretaceous and Lower Tertiary beds from central Alberta were measured, described and sampled. A total of 99 samples were collected; forty-four samples contain abundant microflora and the remainder were left unprocessed or gave no yield. Three-hundred and five morphologic entities were described and coded, 26 of which are stratigraphically important and 59 of vertical significance. Eight new species of Azolla megaspores are described using a different approach to species classification than previously employed by others.

R.C.A. No. 65-1 Core (section I) is used as the standard section with which the plant microfossils in the outcrop sections on the Red Deer River are compared. Three microfloral "zones" are recognized on the basis of species showing vertical and quantitative importance and/or those of stratigraphic significance.

From the data presented, the following conclusions are reached:

(1) The Edmonton Formation in outcrop section III on the Red Deer River, which enc ompassed 120 feet of beds above the "Mauve Shale" and below the Ardley coal seam, correlates with that

portion of the Formation in the lower one-half of R.C.A. No. 65-1 Core, which is represented by the coaly beds below the Whitemud sandstone to approximately 55 feet above the "Mauve Shale". Both are Maestrichtian in age on the basis of species that have been reported only from Maestrichtian or uppermost Cretaceous strata elsewhere.

(2) The Edmonton Formation in outcrop sections II and IV, represented by the Ardley coaly interval on the Red Deer River, correlates with the uppermost portion of the Formation (upper coaly interval) in R.C.A. No. 65-1 Core. This interval probably contains the Cretaceous-Tertiary boundary. Although it was found to contain no species characteristically restricted to uppermost Cretaceous, the total assemblage compares closer to that of section III and the lower strata in R.C.A. No. 65-1 Core than to that in overlying beds above this coaly sequence. The assemblage, however, was found

to contain several species assigned to the Paleocene in other geographic localities as well as two species restricted to uppermost Cretaceous and Paleocene beds elsewhere.

(3) The Paskapoo Formation in R.C.A. No. 65-1 Core seems to be restricted to Paleocene in age. The plant microfossil assemblage most closely resembles the Paleocene microfloral assemblages described by Anderson from New Mexico and Stanley from South Dakota.

CHAPTER FIVE - FORMAL DESCRIPTIONS

CLASS MUSCI

FAMILY SPHAGNACEAE

Genus *Sphagnum* Ehrhart, 1780

Sphagnum regium Drozhastichich, 1961

Plate 5, figure 10

1961 *Sphagnum regium* Drozhastichich, in Samoilovitch, *et al.*, Trudy Vses. Neft. Nauch.-Issled. Geol.-Rasv. Inst., vol. 177, p. 18, pl. 2, figs. 1 a-d, 2, 3.

Description: Trilete; equatorial diameter circular to subcircular; laesurae distinct and about 1/2 of spore radius; exine ornamentation granulate on both proximal and distal surfaces; granules 1 to 2 microns wide; exine approximately 1 micron thick; amb usually smooth.

Size range: Equatorial diameter 20 to 27 microns.

Distribution: Edmonton Formation in R.C.A. No. 65-1 Core, section I ("zones" A and B) and outcrop sections II, III, and IV on the Red Deer River.

Maestrichtian and Paleocene of western Siberia (Drozhastichich, 1961); Ludlow Member (Paleocene), Fort Union Formation, South Dakota (Stanley, 1965).

Locality of figured specimen: R.C.A. No. 65-1 Core

Pl. 5, fig. 10.	Depth 502 to 507 feet;	Edmonton Formation.
Pl. 5, fig. 10.	Slide No. I-54-3;	co-ord. 11/74.4.

DIVISION PTERIDOPHYTA

FAMILY LYCOPODIACEAE

Genus Hamulatisporis Krutzsch, 1959

Type species Hamulatisporis hamulatis Krutzsch, 1959

Hamulatisporis hamulatis Krutzsch, 1959

Plate 3, figures 1, 2

1959 Hamulatisporis hamulatis Krutzsch, Geologie, Jahrg. 8, p. 157, pl. 29, figs. 326-328.

Description: Trilete; equatorial outline circular to subcircular; laesurae about 3/4 of the length of spore radius; hamulate sculpture strongly developed on distal surface and weakly developed on the proximal surface; exine 1 to 2 microns thick.

Size range: Equatorial diameter 30 to 38 microns.

Distribution: Edmonton Formation in R.C.A. No. 65-1 Core, section I ("zone" A) and in outcrop section III on the Red Deer River.

Hell Creek Formation (Maestrichtian), South Dakota (Stanley, 1965); Eocene, Germany (Krutzsch, 1959).

Locality of figured specimens: R.C.A. No. 65-1 Core

Pl. 3, figs. 1, 2.	Depth 455 to 460 feet;	Edmonton Formation.
Pl. 3, figs. 1, 2.	Slide No. I-51-1;	co-ord. 11.1/112.6.

FAMILY CHEIROPLEURIACEAE

Genus *Dictyophyllidites* Couper, 1958

Type species *Dictyophyllidites harrisii* Couper, 1958

Dictyophyllidites sp.

Plate 3, figure 6

Description: Trilete; equatorial outline triangular, sides convex; laesurae raised with thickened lips and about 3/4 of the length of spore radius; exine 0.5 to 1 micron thick and faintly pitted.

Size range: Equatorial diameter 24 to 31 microns.

Distribution: Edmonton Formation in R.C.A. No. 65-1 Core, section I ("zone" A) and in outcrop section III on the Red Deer River.

Locality of figured specimen: R.C.A. No. 65-1 Core

Pl. 3, fig. 6.	Depth 445 to 450 feet;	Edmonton Formation.
Pl. 3, fig. 6.	Slide I-50-1;	co-ord. 15/115.

FAMILY POLYPODIACEAE OR DENNSTAEDTIACEAE

Genus *Laevigatosporites* Ibrahim, 1933, emend. Shopf, Wilson and Bentall, 1944

Type species *Laevigatosporites vulgaris* (Ibrahim) Ibrahim, 1933

Laevigatosporites gracilis Wilson and Webster, 1946

Plate 8, figures 1, 2

1946 *Laevigatosporites gracilis* Wilson and Webster, Am. J. Botany, vol. 33, p. 273, fig. 4.

Description: Monolete; monolete mark faint; equatorial outline kidney-shaped with laesura on the proximal concave side; ornamentation faintly scabrate to smooth; exine 1 to 1.5 microns thick.

Size range: Length 23 to 38 microns.

Breadth 13 to 23 microns.

Distribution: Edmonton and Paskapoo Formations in R.C.A. No. 65-1 Core, subsurface section I ("zones" A, B and C) and in outcrop sections II, III and IV on the Red Deer River.

Fort Union Formation (Paleocene), Montana (Wilson and Webster, 1946).

Potomac Group (Lower Cretaceous), Maryland (Brenner, 1963).

Remarks: *Laevigatosporites gracilis* Wilson and Webster can be distinguished from *Laevigatosporites haardti* (Potonié and Venitz) Thomson and Pflug, 1953, by the lack of a thicker exine in the proximal region and its more elongate outline; and from *Laevigatosporites albertensis* Rouse, 1957, by the lack of a distinctly punctate ornamentation.

Locality of figured specimens: R.C.A. No. 65-1 Core

Pl. 8, fig. 1.	Depth 229 to 233 feet;	Edmonton Formation.
Pl. 8, fig. 1.	Slide No. I-26-1;	co-ord. 13.1/85.7.
Pl. 8, fig. 2.	Depth 229 to 233 feet;	Edmonton Formation.
Pl. 8, fig. 2.	Slide No. I-26-1;	co-ord. 11.9/87.7.

Genus Reticuloidosporites Pflug, 1953

Type species Reticuloidosporites dentatus (Pflug) Pflug, 1953

Reticuloidosporites sp.

Plate 5, figures 11, 12

Description: Monolete; outline elliptical to bean-shaped; proximal surface straight to concave; monolete scar short and indistinct; exine ornamentation reticulate with lumina 1 to 1.5 microns wide; muri about 0.8 micron wide and 1 micron thick, very irregular, often discontinuous and forming an imperfect positive reticulate pattern; exine approximately 1.5 microns thick.

Size range: Length 24 to 33 microns.
Breadth 14 to 23 microns.

Distribution: Edmonton Formation in R.C.A. No. 65-1 Core, section I ("zones" A and B) and outcrop sections II, III and IV on the Red Deer River.

Locality of figured specimens: R.C.A. No. 65-1 Core

Pl. 5, fig. 11.	Depth 221 to 227 feet;	Edmonton Formation.
Pl. 5, fig. 11.	Slide No. I-25-1;	co-ord. 6.9/81.
Pl. 5, fig. 12.	Depth 312 to 319 feet;	Edmonton Formation.
Pl. 5, fig. 12.	Slide No. I-40-3;	co-ord. 16.7/114.

Genus Polypodiisporites Potonié, 1934

Type species Polypodiisporites favus (Potonié) Potonié, 1934

Polypodiisporites sp.

Plate 5, figure 7

Description: Monolete; equatorial outline bean-shaped, proximal surface usually straight; monolete scar distinct; exine ornamented by flat to slightly arched verrucae; verrucae on distal surface large, 2 to 5 microns in diameter and 1 to 3 microns high, irregular in outline, with angular to rounded margins; verrucae on proximal surface absent or very weakly developed; exine 1 to 2 microns thick.

Size range: Length 36 to 55 microns.

Breadth 24 to 34 microns.

Distribution: Edmonton Formation in R.C.A. No. 65-1 Core, section I ("zones" A and B) and outcrop sections II and III on the Red Deer River.

Locality of figured specimen: R.C.A. No. 65-1 Core

Pl. 5, fig. 7.	Depth 221 to 227 feet;	Edmonton Formation.
Pl. 5, fig. 7.	Slide No. I-25-1;	co-ord. 6.9/81.

SPORES-INCERTAE SEDIS

Genus *Cingulatisporites* Thomson, 1953, emend. Potonié, 1956

Type species *Cingulatisporites levispeciousus* Pflug, 1953

Cingulatisporites dakotaensis Stanley, 1965

Plate 5, figures 1, 2

1965 Cingulatisporites dakotaensis Stanley, Bull. Am. Paleont., vol. 49, p. 243, pl. 30, figs. 1-8.

Description: Trilete; equatorial outline subcircular to subtriangular; laesurae gaping to closed, extending from 1/2 to 2/3 radius of the spore; body with a distinct 2 to 4 microns wide cingulum; distal surface exhibiting a Y-shaped thickening rotated 60° in relation to the position of the tetrad mark; exine about 1 micron thick and smooth.

Size range: Equatorial diameter 25 to 29 microns.

Distribution: Edmonton Formation in R.C.A. No. 65-1 Core, section I ("zones" A and B) and outcrop sections II, III and IV on the Red Deer River.

Hell Creek Formation (Maestrichtian) and Ludlow Member (Paleocene) Fort Union Formation, South Dakota (Stanley, 1965).

Locality of figured specimens: R.C.A. No. 65-1 Core

Pl. 5, fig. 1.	Depth 445 to 450 feet;	Edmonton Formation.
Pl. 5, fig. 1.	Slide No. I-50-2;	co-ord. 19.9/77.9.
Pl. 5, fig. 2.	Depth 445 to 450 feet;	Edmonton Formation.
Pl. 5, fig. 2.	Slide No. I-50-2;	co-ord. 10.7/115.

Genus Leptolepidites Couper, 1953

Type species Leptolepidites verrucatus Couper, 1953

Leptolepidites tenuis Stanley, 1965

Plate 1, figure 4

1965 Leptolepidites tenuis Stanley, Bull. Am. Paleont., vol. 49, p. 255, pl. 32, figs. 7-11.

Description: Trilete; equatorial outline subcircular; laesurae distinct, about 3/4 of the length of spore radius; exine about 3 microns thick, ornamented distally with verrucae 3 to 5 microns in diameter and approximately 2 microns high; proximal surface smooth.

Size range: Equatorial diameter 24 to 40 microns.

Distribution: Edmonton Formation in R.C.A. No. 65-1 Core, section I ("zone" A) and in outcrop section III on the Red Deer River.

Hell Creek Formation (Maestrichtian), South Dakota (Stanley, 1965).

Remarks: According to Dettmann (1963), the type species of Leptolepidites Couper is smooth proximally. The illustrations of the proximal surface of Leptolepidites tenuis by Stanley (pl. 32, figs. 7, 9) also appear to be smooth.

Locality of figured specimen: R.C.A. No. 65-1 Core

Pl. 1, fig. 4.	Depth 455 to 460 feet;	Edmonton Formation.
Pl. 1, fig. 4.	Slide No. I-51-1;	co-ord. 11.2/92.

CLASS GYMNOSPERMOPSIDA

ORDER CONIFERALES

FAMILY TAXODIACEAE

Genus Sequoiapollenites Thiergart, 1938

Type species Sequoiapollenites polyformosus Thiergart, 1938

<u>Sequoiapollenites</u> <u>paleocenicus</u> Stanley, 1965

Plate 8, figures 3, 4

1965 <u>Sequoiapollenites</u> <u>paleocenicus</u>, Stanley, Bull. Am. Paleont., vol. 49, p. 282, pl. 38, figs. 8-11.

Description: Inaperturate; outline circular; ligula distinct, 3 to 5 microns long and 3 microns wide, and usually slightly curved; exine 1 to 1.5 microns thick and granulate; granules approximately 1 micron in diameter; exine of ligula and surrounding area smooth to faintly scabrate.

Size range: Diameter 18 to 24 microns.

Distribution: Edmonton and Paskapoo Formations in R.C.A. No. 65-1 Core, section I ("zones" A, B and C) and in outcrop sections II, III and IV on the Red Deer River.

Cannonball and Ludlow Members (Paleocene), Fort Union Formation, South Dakota (Stanley, 1965).

Locality of figured specimens: R.C.A. No. 65-1 Core

Pl. 8, fig. 3.	Depth 221 to 227 feet;	Edmonton Formation.
Pl. 8, fig. 3.	Slide No. I-25-1;	co-ord. 10.1/102.
Pl. 8, fig. 4.	Depth 221 to 227 feet;	Edmonton Formation.
Pl. 8, fig. 4.	Slide No. I-25-1;	co-ord. 10.3/108.1.

Genus <u>Taxodiaceaepollenites</u> Kremp, 1949

Type species <u>Taxodiaceaepollenites</u> <u>hiatus</u> (Potonié) Kremp, 1949

<u>Taxodiaceaepollenites</u> <u>hiatus</u> (Potonié) Kremp, 1949

Plate 8, figure 5

1931 Pollenites hiatus Potonié, Jahrb. Preuss. Geol. L.A. (Berlin) vol. 152, p. 5, fig. 27.

1933 Taxodium hiatipites Wodehouse, Bull. Torrey Botan. Club. vol. 60, p. 493, fig. 19.

1949 Taxodiaceaepollenites hiatus (Potonié) Kremp, Palaeontographica, Band 90, Abt. B, p. 59.

Description: Inaperturate(?); outline spherical to subspherical; distinct split usually occurring with a length 1/3 to 1/2 of the grain diameter; exine 0.5 to 1 micron thick and scabrate to distinctly granulate; granules 0.5 to 0.8 micron wide.

Size range: Diameter 17 to 31 microns.

Distribution: Edmonton and Paskapoo Formations in R.C.A. No. 65-1 Core, section I ("zones" A, B and C) and sections II, III and IV on the Red Deer River.

Oligocene and Miocene, Germany (Kremp, 1949).

Locality of figured specimen: R.C.A. No. 65-1 Core

Pl. 8, fig. 5.	Depth 312 to 319 feet;	Edmonton Formation.
Pl. 8, fig. 5.	Slide No. I-40-3;	co-ord. 16.8/91.7.

ORDER GNETALES

FAMILY EPHEDRACEAE

Genus Equisetosporites Daugherty, 1941, emend. Singh, 1964

Type species Equisetosporites chinleana Daugherty, 1941

Equisetosporites amabilis Srivastava, in press

Plate 2, figure 2

In Press *Equisetosporites amabilis* Srivastava, Can. J. Earth Sciences.

Description: Acolpate; outline ellipsoidal; ektexinous ridges 10 to 12 in number running longitudinally, unbranched, straight, and approximately 4 to 5 microns wide; ridges gently tapering toward the ends and fusing just before reaching the longitudinal ends; furrows between the ridges about 1 micron wide, straight; margin narrow and smooth at both longitudinal ends; exine about 1 micron thick on body increasing to 1.5 to 2 microns at longitudinal ends.

Size range: Length 39 to 47 microns.

Breadth 16 to 21 microns.

Distribution: Edmonton Formation in R.C.A. No. 65-1 Core, section I ("zone" A) and in outcrop section III on the Red Deer River.

Lowermost Edmonton Formation (Maestrichtian), Horseshoe Canyon, Alberta (Srivastava, in press).

Locality of figured specimen: R.C.A. No. 65-1 Core

Pl. 2, fig. 2.	Depth 475 to 480 feet;	Edmonton Formation.
Pl. 2, fig. 2.	Slide No. I-52-1;	co-ord. 16.2/98.

CLASS ANGIOSPERMOPSIDA

SUBCLASS MONOCOTYLEDONEAE

FAMILY LILIACEAE

Genus Liliacidites Couper, 1953

Type species Liliacidites kaitangataensis Couper, 1953

Liliacidites sp.

Plate 6, figure 6

Description: Monosulcate; outline elliptical to subcircular; sulcus moderately long, open and bordered by a distinct thickening; exine ornamentation finely reticulate with lumina less than 0.5 micron in diameter; exine 0.8 to 1 micron in thickness.

Size range: Length 10 to 11 microns.
Breadth 8 to 9 microns.

Distribution: Edmonton Formation in R.C.A. No. 65-1 Core, section I ("zone" B) and in outcrop sections II and IV on the Red Deer River.

Remarks: The muri on Liliacidites sp. appear to be composed of baculae, however, an accurate determination was difficult because of the extremely small sizes.

Locality of figured specimen: R.C.A. No. 65-1 Core

Pl. 6, fig. 6.	Depth 229 to 232 feet;	Edmonton Formation.
Pl. 6, fig. 6.	Slide No. I-26-1;	co-ord. 13.1/85.7.

SUBCLASS DICOTYLEDONEAE

FAMILY VITACEAE

Genus *Vitis* (Tournefort) Linnaeus, 1753

Vitis sp. cf. *V*? *affluens* Stanley, 1965

Plate 7, figures 8, 9

Description: Tricolpate; equatorial outline subround; colpi long, straight and open; pores circular, about 1.5 microns in diameter and with an indistinct annulus; exine less than 1 micron thick, thinner adjacent to the colpi and thicker in the vicinity of the pores; ornamentation very finely reticulate to scabrate.

Size range: Equatorial diameter 12 to 16 microns.

Distribution: Paskapoo Formation in R.C.A. No. 65-1 Core, section I ("zone" C).

Ludlow Member (Paleocene), Fort Union Formation, South Dakota (Stanley, 1965).

Remarks: *Vitis* sp. cf. *V*? *affluens* Stanley, differs from Stanley's specimens in having a subrounded instead of a subtriangular outline, and a smaller size.

Locality of figured specimens: R.C.A. No. 65-1 Core

Pl. 7, figs. 8, 9.	Depth 62 to 66 feet;	Paskapoo Formation.
Pl. 7, figs. 8, 9.	Slide No. I-6-2;	co-ord. 11.1/105.6.

FAMILY BETULACEAE

Genus *Carpinus* (Tournefort) Linnaeus, 1753

Carpinus subtriangula Stanley, 1965

Plate 7, figure 12

1965 Carpinus subtriangula Stanley, Bull. Am. Paleont., vol. 49, p. 291, pl. 43, figs. 12-16.

Description: Triporate; equatorial outline subtriangular to subcircular; pores circular, about 3 microns in diameter, and with slight labrums; exine 0.5 to 1 micron thick and scabrate.

Size range: Equatorial diameter 22 to 35 microns.

Distribution: Paskapoo Formation in R.C.A. No. 65-1 Core, section I ("zone" C).

Cannonball Member (Paleocene), Fort Union Formation, South Dakota (Stanley, 1965).

Remarks: No tetraporate specimens were found. However, the triporate forms recorded have the scabrate ornamentation, thin exine, and simple pore structure characteristic of this species.

Locality of figured specimen: R.C.A. No. 65-1 Core

Pl. 7, fig. 12.	Depth 55 to 60 feet;	Paskapoo Formation.
Pl. 7, fig. 12.	Slide No. I-5-3;	co-ord. 11.5/76.

Genus Betulaceoipollenites Potonié, 1951

Type species Betulaceoipollenites bituitus (Potonié) Potonié, 1951

Betulaceoipollenites sp.

Plate 6, figure 4

Description: Triporate; equatorial outline subcircular; pores large, 2 to 3 microns wide; annulus and vestibulum well developed; body usually with numerous exinal folds; exine 1 to 1.5 microns thick with a scabrate ornamentation.

Size range: Equatorial diameter 25 to 30 microns.

Distribution: Edmonton Formation in R.C.A. No. 65-1 Core, section I ("zone" B) and in outcrop sections II and IV on the Red Deer River.

Locality of figured specimen: R.C.A. No. 65-1 Core

Pl. 6, fig. 4.	Depth 264 to 268 feet;	Edmonton Formation.
Pl. 6, fig. 4.	Slide No. I-30-2;	co-ord. 17.1/119.

Genus Alnus Miller, 1754

Alnus verus (Potonié) Martin & Rouse, 1966

Plate 7, figure 1

1931 Pollenites verus Potonié, Z. Braunkohle, Heft 16, p. 332, pl. 2. fig. 40.

1931 Alni-pollenites verus Potonié, Z. Braunkohle, Heft 16, p. 332.

1933 Alnus speciipites Wodehouse, Bull. Torrey Botan. Club, vol. 60, p. 508, fig. 40.

1934 Alnipollenites verus Potonié-Potonié, Arb. Inst. Palaeobot. Petrogr. Brennsteine, vol. 4, p. 58, pl. 2, fig. 17, (type species).

1953 Polyvestibulopollenites verus (Potonié) Thomson and Pflug, Palaeontographica, Band 94, Abt. B, p. 90, pl. 10, figs. 62-76.

1962 Alnus quinquepollenites Rouse, Micropaleont., vol. 8, p. 202, pl. 2, figs. 7,8.

1962 Alnus quadrapollenites Rouse, Micropaleont., vol. 8, p. 202, pl. 2, figs. 9, 36.

1966 Alnus verus (Potonié) Martin & Rouse, Can. J. Botany, vol. 44, p. 196, pl. 8, figs. 69-71.

Description: Stephanoporate; four to six pored; equatorial outline four to six-sided; pores situated at the angles, elliptical to slit-shaped and normal to the equator; pores protruding with thickened annulus, 5 to 7 microns in diameter; distinct arci about 2 microns wide, looped from pore to pore; ornamentation faintly granulate to scabrate; exine 0.5 to 1 micron thick, increasing to about 1.5 to 2 microns in thickness in pore areas.

Size range: Equatorial diameter 22 to 24 microns.

Distribution: Paskapoo Formation in R.C.A. No. 65-1 Core, section I ("zone" C).

Green River Formation (Eocene), Colorado (Wodehouse, 1933); Eocene and Miocene, Germany (Potonié, 1934) (Potonié and Venitz, 1934); Upper Tertiary, Germany (Thomson and Pflug, 1953); Burrard Formation (Upper Cretaceous to Eocene) British Columbia (Rouse, 1962).

Locality of figured specimen; R.C.A. No. 65-1 Core

Pl. 7, fig. 1.	Depth 15 to 21 feet;	Paskapoo Formation.
Pl. 7, fig. 1.	Slide No. I-1-1;	co-ord. 13.6/116.

Alnus trina Stanley, 1965

Plate 6, figure 13

1965 Alnus trina Stanley, Bull. Am. Paleont., vol. 49, p. 289, pl. 43, figs. 4-6.

Description: Triporate; equatorial outline triangular; sides straight to slightly convex; pores protruding, with definite annulus and labrum; arci well defined about 2 microns in width and paralleling the sides of the grain; exine about 0.5 micron thick increasing to about 2 microns toward the pore regions; exine scabrate.

Size range: Equatorial diameter 12 to 18 microns.

Distribution: Paskapoo and Edmonton Formations in R.C.A. No. 65-1 Core, section I ("zones" B and C).

Ludlow Member (Paleocene), Fort Union Formation, South Dakota (Stanley, 1965).

Locality of figured specimen: R.C.A. No. 65-1 Core

Pl. 6, fig. 13. Depth 15 to 21 feet; Paskapoo Formation.
Pl. 6, fig. 13. Slide No. I-1-1; co-ord. 9/107.5.

Alnus rubriformis Simpson, 1961

Plate 7, figures 10, 11

1961 Alnus rubriformis Simpson, Trans. Roy. Soc. Edinburgh, vol. 64, p. 442, pl. 13, figs. 7, 8.

Description: Staphanoporate; five to six pored; equatorial outline five to six-sided; sides usually straight; pores small and elliptical, strongly aspidate, with annulus and well formed vestibulum and labrum; pores, including

annulus, 5 to 6 microns in diameter; arci indistinct to distinct and about 2 microns wide; exine about 1 to 1.5 microns thick increasing in thickness in the pore region; ornamentation infragranulate.

Size range: Equatorial diameter 20 to 22 microns.

Distribution: Paskapoo Formation in R.C.A. No. 65-1 Core, section I ("zone" C).

Interbasaltic lignites (Early Tertiary), Mull district of Argyllshire, western Scotland (Simpson, 1961).

Remarks: The specimens described in the present study are slightly smaller than the upper size limit of 30 microns of the Scottish specimens.

Locality of figured specimens: R.C.A. No. 65-1 Core

Pl. 7, figs. 10, 11.	Depth 55 to 60 feet;	Paskapoo Formation.
Pl. 7, figs. 10, 11.	Slide No. I-5-3;	co-ord. 12.2/103.

FAMILY TILIACEAE

Genus _Tilia_ Linnaeus, 1753

Tilia tetraforaminipites Wodehouse, 1933

Plate 7, figure 7

1933 _Tilia tetraforaminipites_ Wodehouse, Bull. Torrey Botan. Club, vol. 60, p. 516, fig. 50.

Description: Tetraporate; equatorial outline rectangular; sides convex; pores small, about 1.5 microns wide and 1.5 microns deep, elliptical and not protruding; exine 0.8

to 1 micron thick, increasing slightly in thickness in pore areas; exine very finely pitted.

Size range: Equatorial diameter 24 to 28 microns.

Distribution: Paskapoo Formation in R.C.A. No. 65-1 Core, section I ("zone" C).

Green River Formation (Eocene), Colorado (Wodehouse, 1933); Burrard Formation, Third Beach (Eocene), British Columbia (Rouse, 1962).

Locality of figured specimen: R.C.A. No. 65-1 Core

Pl. 7, fig. 7.	Depth 80 to 90 feet;	Paskapoo Formation.
Pl. 7, fig. 7.	Slide No. I-8-2;	co-ord. 13.9/77.9.

<u>Tilia</u> <u>danei</u> Anderson, 1960

Plate 6, figure 16

1960 <u>Tilia</u> <u>danei</u> Anderson, N. Mex. Bur. Mines and Mineral Resources, Mem. 6, p. 23, pl. 7, figs. 10,11.

Description: Triporate; equatorial outline circular; pores longitudinally elongate with thickened margin; endexine curving inwards at pores and slightly thickened; exine thin, about 0.5 micron in thickness and increasing to about 1 micron at the pores; ornamentation finely reticulate.

Size range: Equatorial diameter 19 to 25 microns.

Distribution: Paskapoo Formation in R.C.A. No. 65-1 Core, section I ("zone" C), and the Edmonton Formation in outcrop section II on the Red Deer River.

Nacimiento Formation (lowermost Paleocene), San Juan Basin, New Mexico (Anderson, 1960).

Locality of figured specimen: R.C.A. No. 65-1 Core

Pl. 6, fig. 16.	Depth 15 to 21 feet;	Paskapoo Formation.
Pl. 6, fig. 16.	Slide No. I-1-1;	co-ord. 11.5/96.6.

FAMILY LORANTHACEAE

Genus Cranwellia Srivastava, 1966

Type species Cranwellia striata (Couper) Srivastava, 1966

Cranwellia rumseyensis Srivastava, 1966

Plate 5, figures 3, 4

1966 Cranwellia rumseyensis Srivastava, Pollen et Spores, vol. 8, p. 538, pl. 11, figs. 3, 7.

Description: Isopolar; tricolpate or possibly tricolporate; equatorial outline triangular with straight to slightly convex sides; apices bluntly rounded; colpi located at apices, about 1/2 of the length of spore radius, narrow, and indistinct; exine 0.5 to 1 micron thick and ornamented with fine striations; striations indistinct in vicinity of poles.

Size range: Equatorial diameter 15 to 24 microns.

Distribution: Edmonton Formation in R.C.A. No. 65-1 Core, section I ("zones" A and B) and in outcrop sections II, III and IV on the Red Deer River.

Edmonton Formation (Maestrichtian), Scollard Area, Alberta (Srivastava, 1966).

Remarks: The specimens described in the present study differ from Srivastava's specimens of C. rumseyensis in having a smaller size. All other characteristics seem to be identical.

Locality of figured specimens: R.C.A. No. 65-1 Core

Pl. 5, fig. 3.	Depth 475 to 480 feet;	Edmonton Formation.
Pl. 5, fig. 3.	Slide No. I-52-1;	co-ord. 7.9/98.
Pl. 5, fig. 4.	Depth 430 to 435 feet;	Edmonton Formation.
Pl. 5, fig. 4.	Slide No. I-49-1;	co-ord. 11.7/85.

FAMILY SALICACEAE

Genus Salixipollenites Srivastava, 1966

Type species Salixipollenites discoloripites (Wodehouse) Srivastava, 1966

Remarks: Forms included in the genus Salixipollenites in the present study consist of only reticulate to broadly-reticulate tricolpate pollen.

Salixipollenites sp. cf. Tricolpites bathyreticulatus Stanley, 1965

Plate 1, figure 8

1965 Tricolpites bathyreticulatus Stanley, Bull. Am. Paleont., vol. 49, p. 320, pl. 47, figs. 18-23.

Description: Tricolpate; equatorial outline sub-circular; colpi straight, gaping; apocolpium small;

ornamentation reticulate, muri moderately high; lumina 1 to 3.5 microns wide; exine thick, endexine less than 1 micron, and ektexine 1 to 1.5 microns thick.

Size range: Equatorial diameter 20 to 23 microns.

Distribution: Edmonton Formation in R.C.A. No. 65-1 Core, section I ("zone" A) and in outcrop section III on the Red Deer River.

Ludlow and Cannonball Members (Paleocene), South Dakota (Stanley, 1965).

Remarks: Salixipollenites sp. cf. T. bathyreticulatus Stanley, has a smaller apocolpium than the specimens described by Stanley (1965). All other characteristics are closely similar.

Locality of figured specimen: R.C.A. No. 65-1 Core

Pl. 1, fig. 8.	Depth 476 to 481 feet;	Edmonton Formation.
Pl. 1, fig. 8.	Slide I-52-1;	co-ord. 23.4/89.

Salixipollenites sp. A

Plate 6, figures 10, 11

Description: Tricolpate; equatorial outline subtriangular; colpi long, apocolpium small; exine ornamentation coarsely reticulate, lumina 0.5 to 1.5 microns wide becoming finer near the margins of the colpi and the poles.

Size range: Equatorial diameter 20 to 23 microns.

Distribution: Edmonton and Paskapoo Formations in R.C.A. No. 65-1 Core, section ("zones" B and C) and the Edmonton Formation in outcrop sections II and IV on the Red Deer River.

Locality of figured specimens: R.C.A. No. 65-1 Core

Pl. 6, figs. 10, 11. Depth 265 to 268 feet; Edmonton Formation.
Pl. 6, figs. 10, 11. Slide No. I-1-2; co-ord. 17.2/74.

<u>Salixipollenites</u> sp. B

Plate 6, figures 8, 9

Description: Tricolpate; prolate; outline ellipsoidal; colpi about 3/4 of length of polar axis with exinous thickenings along borders; ornamentation distinctly reticulate with angular lumina 1 to 1.5 microns wide and muri less than 0.5 micron wide and about 1 micron high; exine approximately 1.8 to 2 microns thick.

Size range: Polar diameter 15 to 17 microns.
Equatorial diameter 9 to 13 microns.

Distribution: Edmonton Formation in R.C.A. No. 65-1 Core, section I ("zone" B) and in outcrop sections II and IV on the Red Deer River.

Locality of figured specimens: R.C.A. No. 65-1 Core

Pl. 6, figs. 8, 9. Depth 54 to 60 feet; Paskapoo Formation.
Pl. 6, figs. 8, 9. Slide No. I-15-3; co-ord. 7.8/9.8.

FAMILY MYRTACEAE

Genus *Myrtaceidites* Cookson and Pike, 1954,
emend. Potonié, 1960

Type species *Myrtaceidites mesonesus* Cookson and Pike, 1954

Myrtaceidites sp. A

Plate 6, figure 5

Description: Tricolporate; equatorial outline triangular; sides convex; angulaperturate; arci indistinct and enclosing a polar island; exine less than 1 micron thick, increasing in thickness near poles; ornamentation granulate with granules about 0.8 micron in diameter.

Size range: Equatorial diameter 16 to 21 microns.

Distribution: Edmonton Formation in R.C.A. No. 65-1 Core, section I ("zone" B) and in outcrop section II on the Red Deer River.

Remarks: The species described above does not contain distinct arci as originally diagnosed for the genus *Myrtaceidites* by Cookson and Pike (1954). In all other respects, however, *Myrtaceidites* sp. A conforms with their generic diagnosis.

Locality of figured specimen: R.C.A. No. 65-1 Core

Pl. 6, fig. 5.	Depth 198 to 203 feet;	Edmonton Formation.
Pl. 6, fig. 5.	Slide No. I-22-3;	co-ord. 13.7/82.3.

Myrtaceidites sp. B

Plate 6, figure 7

Description: Tricolporate; equatorial outline triangular; sides straight to slightly convex; angulaperturate, pores about 2 microns in diameter; arci distinct, making a wide bend near pole and not enclosing a polar island; exine less than 1 micron thick, slightly increasing in thickness near pore areas; ornamentation indistinct to finely granulate.

Size range: Equatorial diameter 12 to 13 microns.

Distribution: Edmonton Formation in R.C.A. No. 65-1 Core, section I ("zone" B) and in outcrop section II on the Red Deer River.

Locality of figured specimen: R.C.A. No. 65-1 Core

Pl. 6, fig. 7.	Depth 175 to 180 feet;	Edmonton Formation.
Pl. 6, fig. 7.	Slide No. I-19-2;	co-ord. 14.6/79.6.

<u>Myrtaceidites</u> sp. C

Plate 6, figure 1

Description: Tricolporate; equatorial outline triangular; sides straight; angulaperturate; pores large and with an annulus about 1 to 2 microns in diameter; arci very distinct, about 2 microns wide, making a moderately gentle bend at the pole and not enclosing a polar island; exine thinning in interaperturate areas, varying from 0.5 to 1.5 microns in thickness; ornamentation granulate, granules about 0.5 micron in diameter.

Size range: Equatorial diameter 16 to 19 microns.

Distribution: Edmonton Formation in R.C.A. No. 65-1 Core, section I ("zone" B), and in outcrop section III on the Red Deer River.

Remarks: Myrtaceidites sp. C differs from Myrtaceidites sp. B in having a larger size, thicker exine, and a coarser ornamentation.

Locality of figured specimen: R.C.A. No. 65-1 Core

Pl. 6, fig. 1.	Depth 275 to 280 feet;	Edmonton Formation.
Pl. 6, fig. 1.	Slide No. I-32-3;	co-ord. 15.5/114.

FAMILY SYMPLOCACEAE

Genus Symplocoipollenites Potonié, 1951

Type species Symplocoipollenites vestibulum (Potonié) Potonié, 1951

Symplocoipollenites vestibulum (Potonié) Potonié, 1951

Plate 2, figure 5

1931 Pollenites vestibulum Potonié, Z. Braunkohle, Heft 16, p. 329, pl. 2, fig. 23.

1951 Symplocoipollenites vestibulum (Potonié) Potonié, Palaeontographica, Band 91, Abt. B, p. 147, pl. 21, figs. 158, 159.

Description: Tricolporate; equatorial outline triangular; sides convex; apertures situated at apices; endexine parting from ektexine in vicinity of each pore forming a very distinct and large vestibulum; depth of vestibulum about 1/3

of the radius of grain; exopore small; colpi narrow extending slightly beyond vestibulum; apocolpium moderate; exine 1 to 1.5 microns thick, ornamentation granulate; granules approximately 0.5 micron wide.

Size range: Equatorial diameter 22 to 25 microns.

Distribution: Edmonton Formation in R.C.A. No. 65-1 Core, section I ("zone" A) and in outcrop section III on the Red Deer River.

Miocene, Germany (Potonié, 1931).

Locality of figured specimen: R.C.A. No. 65-1 Core

Pl. 2, fig. 5.	Depth 445 to 449 feet;	Edmonton Formation.
Pl. 2, fig. 5.	Slide No. I-50-2;	co-ord. 2.5/75.

FAMILY FAGACEAE

Genus <u>Cupuliferoipollenites</u> Potonié, 1951

Type species <u>Cupuliferoipollenites</u> <u>pusillus</u> (Potonié) Potonié, 1951

<u>Cupuliferoipollenites</u> <u>pusillus</u> (Potonié) Potonié, 1951

Plate 5, figures 5, 6

1934 <u>Pollenites</u> <u>quisqualis</u> forma <u>pusillus</u> Potonié, Art. Inst. Paläobot. Petrogr. Brennsteine, vol. 4, p. 71, pl. 3, fig. 21.

1951 <u>Cupuliferoipollenites</u> <u>pusillus</u> (Potonié) Potonié, Palaeontographica, Band 91, Abt. B, p. 150, pl. 20, fig. 69.

Description: Prolate; tricolpate; outline elliptical; furrows long and bordered by a distinct thickening; pores

distinct; exine about 1 micron thick, smooth to scabrate.

Size range: Polar diameter 12 to 18 microns.

Equatorial diameter 8 to 12 microns.

Distribution: Edmonton Formation in R.C.A. No. 65-1 Core, section I ("zones" A and B) and outcrop sections II, III, and IV on the Red Deer River.

Remarks: Cupuliferoipollenites pusillus (Potonié) Potonié, differ from Tricolporites traversei Anderson, 1960, in having a larger size and distinct pores.

Locality of figured specimens: R.C.A. No. 65-1 Core

Pl. 5, fig. 5.	Depth 142 to 147 feet;	Edmonton Formation.
Pl. 5, fig. 5.	Slide No. I-14-3;	co-ord. 12.8/104.
Pl. 5, fig. 6.	Depth 175 to 180 feet;	Edmonton Formation.
Pl. 5, fig. 6.	Slide No. I-19-2;	co-ord. 17.7/91.5.

FAMILY ANACARDIACEAE

Genus Rhoipites Wodehouse, 1933

Type species Rhoipites bradleyi Wodehouse, 1933

Rhoipites sp. cf. R. pisinnus Stanley, 1965

Plate 6, figures 2, 3

1965 Rhoipites pisinnus Stanley, Bull. Am. Paleont., vol. 49, p. 286, pl. 42, figs. 14-23.

Description: Tricolporate; equatorial outline elliptical; pores 1 to 1.5 microns long, about 0.5 micron wide, and paralleling equator; colpi long, straight, slightly open

and possibly bearing caverna; apocolpium moderate; exine 1 to 1.5 microns thick with a microreticulate ornamentation.

Size range: Polar diameter 16 to 17 microns.

Equatorial diameter about 14 microns.

Distribution: Edmonton Formation in R.C.A. No. 65-1 Core, section I ("zone" B) and in outcrop section II on the Red Deer River.

Hell Creek Formation (Maestrichtian) and Ludlow Member (Paleocene), Fort Union Formation, South Dakota (Stanley, 1965).

Remarks: Rhoipites sp. cf. R. pisinnus Stanley, 1965 differs from Stanley's specimens in having a pore of smaller size and an indistinct caverna. All other characteristics are similar.

Locality of figured specimens: R.C.A. No. 65-1 Core

Pl. 6, figs. 2, 3.	Depth 275 to 280 feet;	Edmonton Formation.
Pl. 6, figs. 2, 3.	Slide No. I-32-3;	co-ord. 22.1/92.

FAMILY ULMACEAE

Genus Momipites Wodehouse, 1933

Type species Momipites coryloides Wodehouse, 1933

Momipites sanjuanensis Anderson, 1960

Plate 4, figure 2

1960 Momipities sanjuanensis Anderson, N. Mex. Bur. Mines and Mineral Resources, Mem. 6, p. 25, pl. 11, figs. 1-3.

Description: Triporate; equatorial outline subtriangular; sides convex; pores 1 to 2 microns in diameter with a distinct annulus; pores interconnected by either arci or small folds; exine about 0.5 micron thick with a distinct irregularly scabrate surface ornamentation.

Size range: Equatorial diameter 15 to 17 microns.

Distribution: Edmonton Formation in R.C.A. No. 65-1 Core, section I ("zone" A) and outcrop section III on the Red Deer River.

Lewis shale (uppermost Cretaceous), San Juan Basin, New Mexico (Anderson, 1960).

Locality of figured specimen: R.C.A. No. 65-1 Core

Pl. 4, fig. 2.	Depth 285 to 290 feet;	Edmonton Formation.
Pl. 4, fig. 2.	Slide No. I-34-2;	co-ord. 14.0/74.1.

Momipites inaequalis Anderson, 1960

Plate 6, figure 14

1960 Momipites inaequalis Anderson, N. Mex. Bur. Mines and Mineral Resources, Mem. 6, p. 25, pl. 6, figs. 7-10, pl. 7, fig. 13.

1964 Momipites sp. Newman, Soc. Eco. Paleont. and Mineral., Special Publ. 11, p. 178, pl. 1, fig. 15.

Description: Triporate; equatorial outline triangular; sides slightly convex; pores longitudinally elongate with slightly thickened margins, and not or only slightly protruding; pores about 1.5 to 2 microns in diameter; exine

about 0.5 micron thick increasing to about 1 micron around pores; surface scabrate.

Size range: Equatorial diameter 20 to 28 microns.

Distribution: Paskapoo and Edmonton Formations in R.C.A. No. 65-1 Core, section I ("zones" B and C) and the Edmonton Formation in outcrop sections II and IV on the Red Deer River.

Ojo Alamo sandstone and Nacimiento Formation (lowermost Paleocene), San Juan Basin, New Mexico (Anderson, 1960); Paleocene of northwestern Colorado (Newman, 1964).

Locality of figured specimen: R.C.A. No. 65-1 Core

Pl. 6, fig. 14.	Depth 55 to 60 feet;	Paskapoo Formation.
Pl. 6, fig. 14.	Slide No. I-5-3;	co-ord. 17.5/98.

Momipites tenuipolus Anderson, 1960

Plate 6, figure 14

1960 *Momipites tenuipolus* Anderson, N. Mex. Bur. Mines and Mineral Resources, Mem. 6, p. 25, pl. 7, fig. 14, pl. 8, figs. 14, 15.

Description: Triporate; equatorial outline triangular to subtriangular; sides slightly convex or straight; apices rounded; pores small, longitudinally elongate, not protruding, and diameters about 1.5 microns; exine 1 to 1.5 microns thick, slightly thickened in the pore regions and thinning noticeably in the polar regions; ornamentation scabrate to infragranulate.

Size range: Equatorial diameter 14 to 20 microns.

Distribution: Paskapoo Formation in R.C.A. No. 65-1 Core, section I ("zone" C), and the Edmonton Formation in section II on the Red Deer River.

Nacimiento Formation, (lower Paleocene), San Juan Basin, New Mexico (Anderson, 1960).

Locality of figured specimen: R.C.A. No. 65-1 Core

Pl. 6, fig. 14.	Depth 55 to 60 feet;	Paskapoo Formation.
Pl. 6, fig. 14.	Slide No. I-5-3;	co-ord. 16.5/113.8.

Genus Ulmoideipites Anderson, 1960

Type species Ulmoideipites krempi Anderson, 1960

Ulmoideipites tricostatus Anderson, 1960

Plate 6, figure 12

1958 Triporopollenites undulatus Pflug (part), Wayland, Pflug and Jähnichen, Paleontographica, Band 105, Abt. B, pl. 12, fig. 22.

1960 Ulmoideipites tricostatus Anderson, N. Mex. Bur. Mines and Mineral Resources, Mem. 6, p. 20, pl. 4, figs. 9-11, pl. 6, figs. 4,5, pl. 7, fig. 8, pl. 8, figs. 8, 9.

Description: Triporate; equatorial outline triangular; sides slightly convex; pores subcircular to meridionally elongate, about 1.5 microns in diameter; irregularly verrucate; arci paralleling the sides; surface ornamentation consisting of distinct to indistinct low verrucae; exine 0.5 to 1 micron thick, increasing in thickness in the pore regions

and forming a slight annulus.

Size range: Equatorial diameter 20 to 24 microns.

Distribution: Paskapoo and Edmonton Formations in R.C.A. No. 65-1 Core, section I ("zones" B and C), and the Edmonton Formation in outcrop section II on the Red Deer River.

Ojo Alamo sandstone and Nacimiento Formation (uppermost Cretaceous (?) to lower Paleocene), San Juan Basin, New Mexico (Anderson, 1960); Paleocene of northwestern Colorado (Newman, 1964); Danian, Siberia, U.S.S.R. (Samoilovich, 1967).

Locality of figured specimen: R.C.A. No. 65-1 Core

Pl. 6, fig. 12.	Depth 55 to 60 feet;	Paskapoo Formation.
Pl. 6, fig. 12.	Slide No. I-5-3;	co-ord. 7.2/81.

FAMILY PANDACEAE

Genus Pandanus (Tournefort) Linnaeus, 1753

Pandanus sp? cf. P? shiabensis Simpson, 1961

Plate 7, figure 13

1961 ?Pandanus shiabensis Simpson, Trans. Roy. Soc. Edinburgh, vol. 64, p. 430, pl. 9, fig. 7.

Description: Monoporate; shape spherical; exine covered with 1 to 2 microns long spinules spaced about 2 microns apart and approximately 1 micron wide at bases; pore 1 to 2 microns wide and circular to slightly elliptical in shape; exine 0.5

micron thick, increasing to 1 micron in thickness near the pore; pore region without spinules.

Size range: Diameter 24 to 26 microns.

Distribution: Paskapoo Formation in R.C.A. No. 65-1 Core, section I ("zone" C).

Interbasaltic lignites (Tertiary), Mull district of Argyllshire, western Scotland (Simpson, 1961).

Locality of figured specimen: R.C.A. No. 65-1 Core

Pl. 7, fig. 13.	Depth 45 to 50 feet;	Paskapoo Formation
Pl. 7, fig. 13.	Slide No. I-4-2;	co-ord. 8.2/90.

FAMILY BUXACEAE

Genus Erdtmanipollis Krutzsch, 1962.

Type species Erdtmanipollis pachysandroides Krutzsch, 1962

Remarks: Because it is very difficult to distinguish between the pollen of Pachysandra and Sarcococca (Gray and Sohma, 1964), the present specimens have been assigned to the organ-genus Erdtmanipollis Krutzsch, 1962.

Erdtmanipollis pachysandroides Krutzsch, 1962

Plate 1, figure 5

1962 Erdtmanipollis pachysandroides Krutzsch, Geologie, Jahrg. 11, p. 281, pl. 8, figs. 1-8.

1965 Pachysandra cretacea Stanley, Bull. Am. Paleont., vol. 49, p. 294, pl. 44, figs. 1-9.

Description: Polyporate; equatorial outline spherical;

exine ornamented with plate-like structures arranged next to but not touching one another to form a reticulate pattern; triangular structures present at the junctions of the walls of the reticulum; lumina 3 to 6 microns in diameter; circular pores about 1.5 microns in diameter present in about 1/3 of the lumina; exine about 3 microns thick.

Size range: Diameter 26 to 32 microns.

Distribution: Edmonton Formation in R.C.A. No. 65-1 Core, section I("zone" A) and outcrop section III on the Red Deer River.

Hell Creek Formation (Maestrichtian), Ludlow Member (Paleocene), Fort Union Formation, South Dakota (Stanley, 1965); Upper Oligocene, Germany (Krutzsch, 1962).

Remarks: *Pachysandra cretacea* is distinguished by Stanley (1965) from *Erdtmanipollis pachysandroides* merely on the basis of its slightly wider size range, and is probably a junior synonym.

Locality of figured specimen: R.C.A. No. 65-1 Core

Pl. 1, fig. 5.	Depth 430 to 435 feet;	Edmonton Formation.
Pl. 1, fig. 5.	Slide No. I-49-1;	co-ord. 9.2/90.

FAMILY JUGLANDACEAE

Genus *Caryapollenites* Raatz, 1937

Type species *Caryapollenites simplex* (Potonié) Raatz, 1937

Caryapollenites scabratus Groot and Groot, 1962

Plate 7, figures 4, 5, 6

1962 Caryapollenites scabratus Groot and Groot, Palaeontographica, Band 111, Abt. B., p. 166, pl. 30, figs. 13, 14.

1965 Carya paleocenica Stanley, Bull. Am. Paleont., vol. 49, p. 299, pl. 45, figs. 3-7.

Description: Triporate; equatorial outline subcircular to circular; pores subequatorial, large and circular, about 2 to 3 microns in diameter; ornamentation scabrate to weakly granulate; exine about 1.5 microns thick, slightly thicker in the pore region.

Size range: Equatorial diameter 24 to 28 microns.

Distribution: Paskapoo Formation in R.C.A. No. 65-1 Core, section I ("zone" C).

Cannonball Member (Paleocene), Fort Union Formation, South Dakota (Stanley, 1965); Brightseat Formation (Paleocene), Maryland (Groot and Groot, 1962).

Locality of figured specimens: R.C.A. No. 65-1 Core

Pl. 7, fig. 4.	Depth 15 to 21 feet;	Paskapoo Formation.
Pl. 7, fig. 4.	Slide No. I-1-1;	co-ord. 15/96.8.
Pl. 7, fig. 5.	Depth 15 to 21 feet;	Paskapoo Formation.
Pl. 7, fig. 5.	Slide No. I-1-1;	co-ord. 15/112.7.
Pl. 7, fig. 6.	Depth 15 to 21 feet;	Paskapoo Formation.
Pl. 7, fig. 6.	Slide No. I-1-1;	co-ord. 15.2/111.1.

ANGIOSPERMAE-INCERTAE SEDIS

Genus Aquilapollenites Rouse, 1957, emend.
Funkhouser, 1961

Type species Aquilapollenites quadrilobus
Rouse, 1957

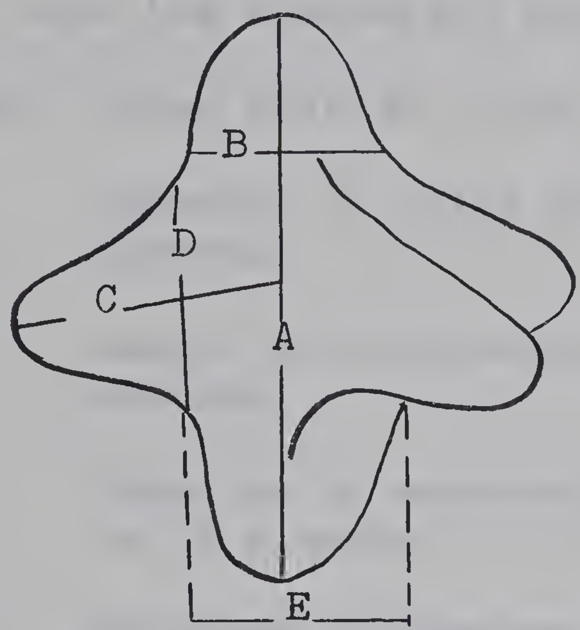

FIGURE 5. Measurements of Aquilapollenites grain. A. Polar axis. B. Diameter of polar protrusion. C. Length of equatorial protrusion. D. Diameter of equatorial protrusion. E. Equatorial diameter of body.

Aquilapollenites reticulatus Stanley, 1961

Plate 1, figures 2, 3

1961 Aquilapollenites reticulatus Stanley, Pollen et Spores, vol. 3, p. 348, pl. 8, figs. 1-12.

Description: Isopolar; tridemicolpate; body with three equatorial and two polar protrusions; diameter of polar protrusions approximately equal to the diameter of the body; equatorial protrusions short, tube-like; colpi distinct, extending from near distal ends and along the

polar edges of the equatorial protrusions onto the body; exine of body reticulate with lumina 0.5 to 1 micron wide and 1 micron high muri; lumina reduced near the base of each equatorial protrusion to a very fine reticulate pattern which continues onto the equatorial protrusions.

Size range: Polar axis 30 to 32 microns.

Diameter of polar protrusions 12 to 15 microns.

Length of equatorial protrusions 17 to 20 microns.

Diameter of equatorial protrusions 12 to 15 microns.

Equatorial diameter of body 18 to 22 microns.

Distribution: Edmonton Formation in R.C.A. No. 65-1 Core, section I ("zone" A).

Hell Creek Formation (Maestrichtian), South Dakota (Stanley, 1961).

Remarks: The specimens of Aquilapollenites reticulatus Stanley, 1961, described in this study, differ from Stanley's specimens in having a microreticulate instead of a concentrically arranged striate pattern on the equatorial protrusions.

Locality of figured specimens: R.C.A. No. 65-1 Core

Pl. 1, fig. 2.	47 to 50 feet above Mauve shale;	Edmonton Formation.
Pl. 1, fig. 2.	Slide No. III-9-1;	co-ord. 21.8/77.4.

Pl. 1, fig. 3. Depth 475 to 480 feet; Edmonton Formation.
Pl. 1, fig. 3. Slide No. I-52-1; co-ord. 6/96.

<u>Aquilapollenites</u> <u>conatus</u> Norton, 1965

Plate 3, figures 7, 8

1965 <u>Aquilapollenites</u> <u>conatus</u> Norton, Pollen et Spores, vol. 7, p. 142, pl. 3, figs. 10, 11, pl. 4, figs. 12-16.

Description: Isopolar; tricolpate; body with three equatorial and two polar protrusions; body rectangular in equatorial view; colpi distinct, extending from distal end of equatorial view; colpi distinct, extending from distal end of equatorial protrusions to the grain body; ornamentation on body and polar protrusions consisting of ridges giving a fingerprint-like sculpture; ridges concentrically arranged around the two slightly projecting corners at the distal end of each polar protrusion; ornamentation on equatorial protrusions reduced to small ridges subparallel to the polar axis; exine of body 1.5 to 2 microns thick; exine of equatorial protrusions approximately 1 micron thick.

Size range: Polar axis 56 to 60 microns.

Diameter of polar protrusions 18 to 20 microns.

Length of equatorial protrusions about 27 microns.

Diameter of equatorial protrusions 12 to 14 microns.

Equatorial diameter of body about 20 microns.

Distribution: Edmonton Formation in R.C.A. No. 65-1 Core, section I ("zone" A) and in outcrop section III on the Red Deer River.

Hell Creek Formation (Maestrichtian), Montana (Norton, 1965).

Locality of figured specimens: R.C.A. No. 65-1 Core

Pl. 3, figs. 7, 8.	Depth 285 to 290 feet;	Edmonton Formation.
Pl. 3, figs. 7, 8.	Slide No. I-34-2;	co-ord. 12.3/82.

<u>Aquilapollenites</u> <u>spinulosus</u> Funkhouser, 1961

Plate 7, figures 2, 3

1961 <u>Aquilapollenites</u> <u>spinulosus</u> Funkhouser, Micropaleont., vol. 7, pl. 194, pl. 1, figs. 4-6.

Description: Isopolar; tridemicolpate; body with three equatorial and two polar protrusions; diameter of equatorial protrusions approximately equal to the diameter of polar portrusions; demicolpi located within the concavities formed between the equatorial and the polar protrusions; smooth, narrow, thickened bands paralleling each demicolpi; remainder of the body covered by randomly spaced spinules about 0.5 to 1 micron long and 1 to 2 microns apart; spinules on the equatorial protrusions curving back toward the poles.

Size range: Polar axis 32 to 36 microns.

Diameter of polar protrusions 10 to 12 microns.

Length of equatorial protrusions 15 to 18 microns.

Diameter of equatorial protrusions 10 to 12 microns.

Equatorial diameter of body 12 to 15 microns.

Distribution: Paskapoo Formation in R.C.A. No. 65-1 Core, section I ("zone" C).

Fort Union Formation (Paleocene), Wyoming, and Eocene of the Rocky Mountain area (Funkhouser, 1961).

Locality of figured specimens: R.C.A. No. 65-1 Core

Pl. 7, fig. 2.	Depth 80 to 90 feet;	Paskapoo Formation.
Pl. 7, fig. 2.	Slide No. I-8-2;	co-ord. 13.5/114.
Pl. 7, fig. 3.	Depth 15 to 21 feet;	Paskapoo Formation.
Pl. 7, fig. 3.	Slide No. I-1-1;	co-ord. 13.6/110.

<u>Aquilapollenites</u> <u>delicatus</u> Stanley, 1961

Plate 3, figures 9, 10

1961 <u>Aquilapollenites</u> <u>delicatus</u> Stanley, Pollen et Spores, vol. 3, p. 346, pl. 4, figs. 1-12.

Description: Heteropolar; tricolpate; body with three equatorial and two markedly unequal polar protrusions; one polar protrusion extremely reduced; diameter of larger polar protrusion about equal to diameter of equatorial

protrusions; colpi indistinct and restricted to the distal end of each equatorial protrusion; body reticulate, with largest lumina of up to 2 microns wide near the base of the larger polar protrusion; reticulate pattern formed by clavae 1 to 2 microns high; spinules up to 3 microns long and 1 to 2 microns wide present on the body and the basal portion of the polar protrusions; ektexine of equatorial protrusions scabrate with a few widely separated clavae; exinous thickenings present along the concave junctions between the polar and equatorial protrusions and extending for a short distance onto the equatorial protrusions.

Size range: Polar axis 40 to 45 microns.

Diameter of polar protrusion about 14 microns.

Length of equatorial protrusions 26 to 32 microns.

Diameter of equatorial protrusions about 12 microns.

Equatorial diameter of body 14 to 16 microns.

Distribution: Edmonton Formation in R.C.A. No. 65-1 Core, section I ("zone" A).

Hell Creek Formation (Maestrichtian), South Dakota (Stanley, 1961).

Remarks: The specimens of Aquilapollenites delicatus Stanley, 1961, described in this study are slightly larger

than those described by Stanley (1961).

Locality of figured specimens: R.C.A. No. 65-1 Core

Pl. 3, figs. 9, 10. Depth 285 to 290 feet; Edmonton Formation.
Pl. 3, figs. 9, 10. Slide No. I-34-2; co-ord. 15.4/87.5.

Aquilapollenites polaris Funkhouser, 1961

Plate 1, figure 1

1961 *Aquilapollenites polaris* Funkhouser, Micropaleont., vol. 7, p. 198, pl. 1, figs. 1, 2.

Description: Heteropolar; tridemicolpate; body with three equatorial and two unequal polar protrusions; one polar protrusion extremely reduced; diameter of the larger polar protrusion less than 1/2 of the length of the polar axis and slightly more or equal to the width of the equatorial protrusions; equatorial protrusions about 2/3 of the length of polar axis; demicolpi extending from the base of the larger polar protrusion to about half-way up the equatorial protrusions; exine thickened along the margins of the demicolpi; body covered with spinules and coarse punctae; spinules up to 1 micron long in polar regions and missing along the thickened margins of demicolpi.

Size range: Polar axis 32 to 34 microns.

Diameter of polar protrusions 13 to 18 microns.

Length of equatorial protrusions about 20 microns.

Diameter of equatorial protrusions 12 to 19 microns.

Equatorial diameter of body 20 to 22 microns.

Distribution: Edmonton Formation in R.C.A. No. 65-1 Core, section I ("zone" A).

Lance Formation (Maestrichtian), Wyoming (Funkhouser, 1961); Maestrichtian, Siberia, U.S.S.R. (Bratzeva, 1967).

Remarks: The specimens of Aquilapollenites polaris Funkhouser, 1961, described in this study differ from Funkhouser's specimens in having a polar protrusion which is wider or equal in width to the equatorial protrusions, instead of being narrower. This effect is probably created by the grain orientation.

Locality of figured specimen: R.C.A. No. 65-1 Core

Pl. 1, fig. 1.	Depth 445 to 450 feet;	Edmonton Formation.
Pl. 1, fig. 1.	Slide No. I-50-1;	co-ord. 14.2/104.

Aquilapollenites sp. cf. A. attenuatus Funkhouser, 1961

Plate 2, figures 6, 7

1961 Aquilapollenites attenuatus Funkhouser, Micropaleont., vol. 7, p. 194, pl. 2, figs. 1 a-c.

Description: Isopolar; tridemicolpate; body with three equatorial and two polar protrusions; diameter of

equatorial protrusions about 1/3 length of polar axis; demicolpi located within the concavities formed between the equatorial and polar protrusions; ornamentation finely reticulate with lumina varying from 0.5 micron in diameter on the polar and equatorial protrusions to approximately 1 micron on the body; muri up to 1 micron thick on the body; spinules 1 to 3 microns long restricted to the polar protrusions, distal portions of the equatorial protrusions, and narrow strips along the equatorial sides of each equatorial protrusion.

Size range: Polar axis 39 to 67 microns.

Diameter of polar protrusions 16 to 25 microns.

Length of equatorial protrusions 28 to 50 microns.

Diameter of equatorial protrusions 12 to 19 microns.

Equatorial diameter of body about 18 to 26 microns.

Distribution: Edmonton Formation in R.C.A. No. 65-1 Core, section I ("zone" A).

Lance Formation (Maestrichtian), Wyoming (Funkhouser, 1961).

Remarks: Funkhouser (1961) described <u>Aquilapollenites attenuatus</u> as coarsely punctate. The specimens examined in the present study are finely reticulate and include forms

which are slightly smaller to larger than Funkhouser's specimens.

Locality of figured specimens: R.C.A. No. 65-1 Core

Pl. 2, fig. 6.	Depth 453 to 460 feet;	Edmonton Formation.
Pl. 2, fig. 6.	Slide No. I-51-1;	co-ord. 15.2/100.
Pl. 2, fig. 7.	Depth 455 to 460 feet;	Edmonton Formation.
Pl. 2, fig. 7.	Slide No. I-51-1;	co-ord. 14/117.9.

<u>Aquilapollenites</u> <u>reductus</u> Norton, 1965

Plate 1, figures 9, 10; plate 2, figure 1

1965 <u>Aquilapollenites</u> <u>reductus</u> Norton, Pollen et Spores, vol. 7, p. 140, pl. 2, figs. 5-7, pl. 3, figs. 8, 9.

Description: Isopolar; tricolpate; body with three equatorial protrusions and two broad polar protrusions; diameter of the polar protrusions approximately equal to the diameter of the body; colpi located on the distal end of each equatorial protrusion; ornamentation on body reticulate, with 2 microns wide lumina near equator and about 0.5 micron wide near poles; distal portion of each equatorial portrusion reticulate and the proximal portion smooth; lumina on equatorial protrusions 0.5 to 1 micron in width; exine approximately 1 micron thick at the poles to about 2.5 microns at the equator.

Size range: Polar axis 40 to 48 microns.

Diameter of polar protrusions 15 to 18 microns.

Length of equatorial protrusion 15 to 20 microns.

Diameter of equatorial protrusions 7 to 10 microns.

Equatorial diameter of body 20 to 25 microns.

Distribution: Edmonton Formation in R.C.A. No. 65-1 Core, section I ("zone" A) and in outcrop section III on the Red Deer River.

Hell Creek Formation (Maestrichtian), Montana (Norton, 1965).

Locality of figured specimens: R.C.A. No. 65-1 Core

Pl. 1, figs. 9, 10.	Depth 445 to 449 feet;	Edmonton Formation.
Pl. 1, figs. 9, 10.	Slide No. I-50-2;	co-ord. 11.1/89.2.
Pl. 2, fig. 1.	Depth 476 to 481 feet;	Edmonton Formation.
Pl. 2, fig. 1.	Slide No. I-52-1;	co-ord. 20.3/78.

Aquilapollenites amplus Stanley, 1961

Plate 1, figure 6

1961 *Aquilapollenites amplus* Stanley, Pollen et Spores, vol. 3, p. 342, pl. 1, figs. 1-6, pl. 2, figs. 1-4, pl. 3, figs. 1-5.

Description: Isopolar; tricolpate; body with three equatorial and two polar protrusions; colpi distinct and located on the distal portions of the equatorial protrusions; ornamentation on body and protrusions reticulate with lumina about 0.5 micron wide on equatorial protrusions increasing in size on the body and enlarging to about 1

micron near the poles; clavae forming muri on the body and polar protrusions 1.5 to 2 microns high; moderate amount of randomly spaced spinules over entire surface; spinules on body about 4 microns long and on equatorial protrusions approximately 2 microns long and directed back toward the body; boomerang shaped thickenings along the polar edges of the equatorial protrusions and extending a short distance onto the body.

Size range: Polar axis 42 to 55 microns.

Diameter of polar protrusions 14 to 19 microns.

Length of equatorial protrusions 20 to 30 microns.

Diameter of equatorial protrusions 14 to 18 microns.

Equatorial diameter of body 14 to 24 microns.

Distribution: Edmonton Formation in R.C.A. No. 65-1 Core, section I ("zone" A) and in outcrop section III on the Red Deer River.

Hell Creek Formation (Maestrichtian), South Dakota (Stanley, 1965).

Locality of figured specimen: R.C.A. No. 65-1 Core

Pl. 1, fig. 6.	Depth 314 to 317 feet;	Edmonton Formation.
Pl. 1, fig. 6.	Slide No. I-40-3;	co-ord. 12.5/116.1

Aquilapollenites sp. cf. A. quadricretaceus Chlonova, 1961

Plate 4, figures 6, 7, 8

1961 Aquilapollenites quadricretaceus Chlonova, Trudy Inst. Geol. Geophys., Sib. Otdel., Akad. Nauk SSSR, Novosibirsk, no. 7, p. 84, pl. 14, fig. 108 a-b.

Description: Isopolar; tricolpate; body with three equatorial protrusions with axes normal to the polar axis; diameter of equatorial protrusions approximately equal to the diameter of the polar protrusions; colpi located at the distal end of each equatorial protrusion; ektexine consisting of clavae about 1 to 1.5 microns long and about 1 micron in width; clavae, distinctly separated over most of the body and passing to a reticulate pattern near the poles; lumina approximately 1 micron in diameter.

Size range: Polar axis 45 to 55 microns.

Diameter of polar protrusions 11 to 14 microns.

Length of equatorial protrusions 21 to 28 microns.

Diameter of equatorial protrusions 11 to 14 microns.

Equatorial diameter of body about 14 microns.

Distribution: Edmonton Formation in R.C.A. No. 65-1 Core, section I ("zone" A) and in outcrop section III on the Red Deer River.

Vakh River Basin (Maestrichtian to Danian), U.S.S.R. (Chlonova, 1961).

Remarks: Aquilapollenites sp. cf. A. quadricretaceus differs from Aquilapollenites quadricretaceus Chlonova, 1961, in having an intectate ektexine with clavae completely separated over most of the grain surface. A few specimens do, however, exhibit an ektexine which becomes more tectate in areas other than the tips of the polar protrusions. In other respects, these specimens compare closely to Aquilapollenites quadricretaceus Chlonova, 1961.

Locality of figured specimens: R.C.A. No. 65-1 Core

Pl. 4, figs. 6, 7.	Depth 285 to 290 feet;	Edmonton Formation.
Pl. 4, figs. 6, 7.	Slide No. I-34-2;	co-ord. 14.2/97.7.
Pl. 4, fig. 8.	Depth 285 to 290 feet;	Edmonton Formation.
Pl. 4, fig. 8.	Slide No. I-34-2;	co-ord. 7.5/97.1.

Aquilapollenites sp. A

Plate 2, figure 10

Description: Isopolar; tridemicolpate; three equatorial and two polar protrusions; diameter of polar protrusions about equal to diameter of equatorial protrusions; demicolpi located within the concavities formed between the equatorial and the polar protrusions; smooth, narrow, thickened bands paralleling each demicolpi; remainder of the body covered by a fine bertillon (fingerprint) pattern;

spinules approximately 4 microns high at tips of all protrusions and sparsely distributed over the remaining surface.

Size range: Polar axis 34 to 36 microns.

Diameter of polar protrusions 15 to 18 microns.

Length of equatorial protrusions 20 to 22 microns.

Diameter of equatorial protrusions 12 to 14 microns.

Equatorial diameter of body about 18 microns.

Distribution: Edmonton Formation in R.C.A. No. 65-1 Core, section I ("zone" A).

Remarks: Because of relatively few poorly orientated specimens, the nature and the position of the colpi could not be ascertained precisely. Although the specimens appear to exhibit a tridemicolpi condition, it seems possible that they may be tricolpate with colpi restricted to the distal portions of each equatorial protrusion.

Locality of figured specimen: R.C.A. No. 65-1 Core

Pl. 2, fig. 10.	Depth 445 to 450 feet;	Edmonton Formation.
Pl. 2, fig. 10.	Slide No. I-50-1;	co-ord. 6/96.

<u>Aquilapollenites</u> sp. B

Plate 3, figures 3, 4, 5

Description: Isopolar; tridemicolpate; body with

three equatorial and two polar protrusions; diameter of polar and equatorial protrusions approximately 1/2 the polar axis; demicolpi short, located within the concavities formed between the equatorial and polar protrusions; smooth, short, thickened bands paralleling each demicolpi; spinules 0.5 to 1 micron long covering entire surface of body and densely packed near distal ends of equatorial protrusions; some specimens showing only a few very small spinules in the vicinity of the poles.

Size range: Polar axis 19 to 22 microns.

Diameter of polar protrusions 8 to 10 microns.

Length of equatorial protrusions 8 to 12 microns.

Diameter of equatorial protrusions 8 to 10 microns.

Equatorial diameter of body about 10 microns.

Distribution: Edmonton Formation in R.C.A. No. 65-1 Core, section I ("zone" A).

Locality of figured specimens: R.C.A. No. 65-1 Core

Pl. 3, figs. 3, 4.	Depth 312 to 319 feet;	Edmonton Formation.
Pl. 3, figs. 3, 4.	Slide No. I-40-3;	co-ord. 16.7/100.5.
Pl. 3, fig. 5.	Depth 312 to 319 feet;	Edmonton Formation.
Pl. 3, fig. 5.	Slide No. I-40-3;	co-ord. 14.9/91.5.

Aquilapollenites sp. C

Plate 2 figures 8, 9

Description: Isopolar; tridemicolpate; body with three equatorial and two polar protrusions; diameter of polar protrusions approximately 1/3 of polar axis; equatorial protrusions constricted near their bases; demicolpi located within the concavities formed between the equatorial and polar protrusions and extending from the constricted bases of the equatorial portrusions to 2/3 the distance to the poles; reticulate ornamentation with lumina approximately 1 micron in diameter and muri 1 to 1.5 microns high occurring on body, polar protrusions, and near bases of equatorial protrusions; ornamentation on the distal portions of the equatorial protrusions consisting of a very fine striatoreticulate pattern with lumina less than 0.5 micron in diameter.

Size range: Polar axis 33 to 38 microns.

Length of equatorial protrusions 15 to 18 microns.

Diameter of equatorial protrusions 12 to 13 microns.

Equatorial diameter of body about 25 microns.

Distribution: Edmonton Formation in R.C.A. No. 65-1 Core, section I ("zone" A) and in outcrop section III on the

Red Deer River.

Locality of figured specimens: R.C.A. No. 65-1 Core

Pl. 2, figs. 8, 9.	Depth 445 to 449 feet;	Edmonton Formation.
Pl. 2, figs. 8, 9.	Slide No. I-50-3;	co-ord. 5.4/93.

Genus Scollardia Srivastava, 1966

Type species Scollardia trapaformis Srivastava, 1966

Scollardia steevesi Srivastava, 1966

Plate 5, figures 8, 9

1966 Scollardia steevesi Srivastava, Pollen et Spores, vol. 8, p. 545, pl. 10, figs. 4, 5, 7.

Description: Isopolar; tricolpate; equatorial outline triangular with three equatorial protrusions at the apices; sides straight to slightly concave or convex; colpi long extending from the tips of equatorial protrusions to the polar area, usually with a distinct to indistinct thickened margin; tips of equatorial protrusions often crumpled or bent; exine striate with striations running parallel to each other and roughly normal to the axes of the equatorial protrusions; exine about 1 micron thick.

Size range: Equatorial diameter 30 to 45 microns.

Distribution: Edmonton Formation in R.C.A. No. 65-1 Core, section I ("zones" A and B) and outcrop sections II, III, and IV on the Red Deer River.

Edmonton Formation (Maestrichtian), Scollard Area, Alberta (Srivastava, 1966).

Locality of figured specimens: R.C.A. No. 65-1 Core

Pl. 5, fig. 8.	Depth 475 to 480 feet;	Edmonton Formation.
Pl. 5, fig. 8.	Slide No. I-52-1;	co-ord. 7.9/98.
Pl. 5, fig. 9.	Depth 430 to 435 feet;	Edmonton Formation.
Pl. 5, fig. 9.	Slide No. I-49-1;	co-ord. 11.7/85.

Genus Tricolpites Cookson, 1947 ex Couper, 1953, emend. Potonié, 1960

Type species Tricolpites reticulatus Cookson, 1947

Remarks: Forms included in genus Tricolpites in the present study are restricted to only finely reticulate to microreticulate tricolpate pollen.

Tricolpites sp. A

Plate 5, figure 14

Description: Tricolpate; prolate; outline elliptical; colpi long and narrow; apocolpium small; endexine less than 0.5 micron thick, ektexine with pila about 1 micron thick; pila arranged to produce a fine striatoreticulate ornamentation.

Size range: Polar diameter 16 to 25 microns.

Distribution: Edmonton Formation in R.C.A. No. 65-1 Core, section I ("zones" A and B) and outcrop sections II, III and IV on the Red Deer River.

Remarks: Tricolpites sp. A differs from Tricolpites striatus in being considerably smaller in size and having a finer striatoreticulate sculpture.

Locality of figured specimen: R.C.A. No. 65-1 Core

Pl. 5, fig. 14. Depth 286 to 291 feet; Edmonton Formation.
Pl. 5, fig. 14. Slide No. I-34-2; co-ord. 4.8/82.

Tricolpites sp. B

Plate 5, figure 13

Description: Tricolpate; equatorial outline subtriangular; sides strongly convex; intercolpate margins arching into apices; apocolpium small to moderate; colpi straight and narrow; exine ornamentation microreticulate, lumina 0.5 micron or less in diameter; exine about 1 micron thick.

Size range: Equatorial diameter 24 to 27 microns.

Distribution: Edmonton Formation in R.C.A. No. 65-1 Core, section I ("zones" A and B) and outcrop section II, III and IV on the Red Deer River.

Remarks: Tricolpites sp. B is similar to Tricolpites microreticulatus Belsky et al., 1965, in size and ornamentation. However, the equatorial outline of Tricolpites sp. B is more triangular than circular.

Locality of figured specimen: R.C.A. No. 65-1 Core

Pl. 5, fig. 13. Depth 312 to 319 feet; Edmonton Formation.
Pl. 5, fig. 13. Slide No. I-40-3; co-ord. 80/20.3.

Genus *Kurtzipites* Anderson, 1960

Type species *Kurtzipites trispissatus* Anderson, 1960

Kurtzipites trispissatus Anderson, 1960

Plate 4, figure 1

1960 *Kurtzipites trispissatus* Anderson, N. Mex. Bur. Mines and Mineral Resources, Mem. 6, p. 25, pl. 2, figs. 15-17.

Description: Triporate; equatorial outline hexagonal; interpore areas sharply convex at midpoints; pores slit-like with a distinctive crescentic to triangular opaque thickening behind each pore; thickened patches 3 to 4 microns in diameter; pores showing very little thickening elsewhere; overall thickness of exine about 0.5 micron; ornamentation indistinct, possibly microreticulate.

Size range: Equatorial diameter about 22 microns.

Distribution: Edmonton Formation in R.C.A. No. 65-1 Core, section I ("zone" A) and outcrop section III on the Red Deer River.

Kirtland shale (uppermost Cretaceous), San Juan Basin, New Mexico (Anderson, 1960).

Locality of figured specimen: R.C.A. No. 65-1 Core

Pl. 4, fig. 1.	Depth 313 to 319 feet;	Edmonton Formation.
Pl. 4, fig. 1.	Slide No. I-40-3;	co-ord. 18.8/110.8.

<u>Kurtzipites</u> sp.

Plate 5, figures 15, 16

Description: Triporate; equatorial outline subcircular to subtriangular; triangular or crescent-shaped thickenings surrounding the pores with the apices of the triangules or crescents pointing toward the poles; pores longitudinally elongate with slightly thickened margins and 0.5 to 1 micron in diameter; exine less than 1 micron thick; ornamentation indistinct to scabrate.

Size range: Equatorial diameter 16 to 24 microns.

Distribution: Edmonton Formation in R.C.A. No. 65-1 Core, section I ("zones" A and B) and in outcrop sections II and IV on the Red Deer River.

Remarks: <u>Kurtzipites</u> sp. differs from <u>Kurtzipites trispissatus</u> Anderson, 1960, in the absence of a sharply convex midpoint between the pores.

Locality of figured specimens: R.C.A. No. 65-1 Core

Pl. 5, fig. 15.	Depth 275 to 280 feet;	Edmonton Formation.
Pl. 5, fig. 15.	Slide No. I-32-3;	co-ord. 21.1/105.
Pl. 5, fig. 16.	Depth 312 to 319 feet;	Edmonton Formation.
Pl. 5, fig. 16.	Slide No. I-40-3;	co-ord. 12.6/104.7.

INCERTAE SEDIS

Genus Schizosporis Cookson and Dettmann, 1959

Type species Schizosporis reticulatus, Cookson and Dettmann, 1959

Schizosporis complexus Stanley, 1965

Plate 1, figure 7

1965 Schizosporis complexus Stanley, Bull. Am. Paleont., vol. 49, p. 267, pl. 36, figs. 7-17.

Description: Inaperturate(?); outline circular to subcircular; exine ornamentation reticulate; lumina 1 to 3 microns wide; muri composed of two rows of 1 to 2 microns high baculae; a fissure or tear paralleling the long axis of the grain almost always present.

Size range: Diameter 38 to 50 microns.

Distribution: Edmonton Formation in R.C.A. No. 65-1 Core, section I ("zone" A).

Hell Creek Formation (Maestrichtian), South Dakota (Stanley, 1965).

Locality of figured specimen: R.C.A. No. 65-1 Core

Pl. 1, fig. 7.	Depth 445 to 450 feet;	Edmonton Formation.
Pl. 1, fig. 7.	Slide No. I-50-1;	co-ord. 13.7/106.

Genus Ovoidites Potonié, 1951, emend. Potonié, 1966

Type species Ovoidites ligneolus (Potonié) Potonié, 1951

Ovoidites *ligneolus* (Potonié) Potonié, 1951

Plate 7, figure 14

1931 *Pollenites* (?) *ligneolus* Potonié, Sitzber. Ges. Naturf. Freunde (Berlin), no. 1-3, p. 28, pl. 2, fig. V25a.

1951 *Ovoidites* *ligneolus* (Potonié) Potonié, Palaeontographica, Band 91, Abt. B, p. 150, pl. 21, fig. 185.

1965 ?*Schizosporis* sp. or *Ovoidites* sp. Harris, Geol. Surv. Queensland, Rept. 10, fig. 10.

Description: Inaperturate; body fusiform to elongate-elliptical in shape, usually splitting approximately in half by an elongate fissure; exine 2 to 2.5 microns thick, surface irregularly reticulate with 1 to 1.5 microns wide muri.

Size range: Length 65 to 90 microns.

Breadth 28 to 36 microns.

Distribution: Paskapoo Formation in R.C.A. No. 65-1 Core, section I ("zone" C).

Tertiary strata of Brisbane Queensland (Harris, 1965); Cannonball Member (Paleocene), Fort Union Formation, South Dakota (Stanley, 1965); Oligocene and Miocene of Germany (Potonié, 1931).

Locality of figured specimen: R.C.A. No. 65-1 Core

Pl. 7, fig. 14.	Depth 55 to 60 feet;	Paskapoo Formation.
Pl. 7, fig. 14.	Slide No. I-5-3;	co-ord. 16/78.3.

Genus *Sigmopollis* Hedlund, 1965

Type species Sigmopollis hispidus Hedlund, 1965

Sigmopollis hispidus Hedlund, 1965

Plate 2, figures 3, 4

1965 Sigmopollis hispidus Hedlund, Pollen et Spores, vol. 7, p. 92, pl. 1, figs. 1-12.

Description: Aperture single; body spherical, outline circular to subcircular; aperture doubly recurved, sigmoidal; exine less than 1 micron thick, ornamented with spinules about 0.5 micron long, densely distributed.

Size range: Diameter 15 to 24 microns.

Distribution: Edmonton Formation in R.C.A. No. 65-1 Core, section I ("zone" A) and outcrop section III on the Red Deer River.

Miocene, Elko County, Nevada (Hedlund, 1965).

Locality of figured specimens: R.C.A. No. 65-1 Core

Pl. 2, fig. 3.	Depth 285 to 290 feet;	Edmonton Formation.
Pl. 2, fig. 3.	Slide No. I-34-1;	co-ord. 10.4/115.9.
Pl. 2, fig. 4.	Depth 475 to 480 feet;	Edmonton Formation.
Pl. 2, fig. 4.	Slide No. I-52-1;	co-ord. 4.6/77.9.

Genus Wodehousia Stanley, 1961

Type species Wodehousia spinata Stanley, 1961

Wodehousia spinata Stanley, 1961

Plate 4, figures 3-5

1961 Wodehousia spinata Stanley, Pollen et Spores, vol. 3, p. 157, pl. 1, figs. 1-12.

Description: Tetraporate; dorso-ventral outline of body elliptical with a well developed flange; flange 2 to 4 microns wide along longitudinal ends and 5 to 7 microns wide along lateral edges; membrane of the flange pitted and supported by 6 to 12 microns long knobby spines; spines numbering 10 to 11 on each surface; two pores on each surface, pores elliptical to slit-like, and elongated parallel to the minor axis of central body; exine very finely granulate.

Size range: Length of body including flange 34 to 48 microns.

Breadth of body including flange 15 to 35 microns.

Distribution: Edmonton Formation in R.C.A. No. 65-1 Core, section I ("zone" A) and outcrop section III on the Red Deer River.

Hell Creek Formation (Maestrichtian) South Dakota (Stanley, 1961); Hell Creek Formation (Maestrichtian) Montana (Norton and Hall, 1967); Maestrichtian, Siberia, U.S.S.R. (Bratzeva, 1967).

Locality of figured specimens: R.C.A. No. 65-1 Core

Pl. 4, fig. 3.	102 to 105 feet above Mauve shale;	Edmonton Formation.
Pl. 4, fig. 3.	Slide No. III-1-1;	co-ord. 9.9/114.8.
Pl. 4, fig. 4.	102 to 105 feet above Mauve shale;	Edmonton Formation.
Pl. 4, fig. 4.	Slide No. III-1-1;	co-ord. 16/101.9.
Pl. 4, fig. 5.	Depth 313 to 319 feet;	Edmonton Formation.
Pl. 4, fig. 5.	Slide No. I-40-3;	co-ord. 11.2/90.1.

MEGASPORES

Genus Balmeisporites Cookson and Dettmann, 1958

Type species Balmeisporites holodictyus Cookson and Dettmann, 1958

Balmeisporites striatellus Kondinskaya, 1966

Plate 8, figures 6, 7

1966 Balmeisporites striatellus Kondinskaya, Palynology of Siberia, Trudy Inst. Geol. Geophys., Sib. Otdel., Akad. Nauk SSSR, Novosibirsk, p. 118, pl. 2, fig. 1.

Description: Trilete megaspore; spore body circular in outline, with ridged and rib-like outer surface; neck composed of three segments, finely granulate, approximately equal to the body diameter in length; exospore double-layered; inner layer smooth, 1 to 4 microns thick; outer layer finely granulate ornamented by thin subparallel ridges 2 to 3 microns wide; ridges interconnected by rib-like structures, rib-like structures 1 to 1.5 microns wide, very irregular, branching, discontinuous to continuous.

Size range: Total length of megaspore (5 specimens) 100 to 350 microns.

Diameter of megaspore body (10 specimens) 50 to 180 microns.

Distribution: Edmonton Formation in R.C.A. No. 65-1 Core, section I ("zone" A) and in outcrop section III along the Red Deer River; uppermost St. Mary River Formation in outcrops along the Oldman River north of Fort Macleod (figure 1).

Upper Cretaceous, Siberia, U.S.S.R.(Kondinskaya, 1966).

Locality of figured specimens: R.C.A. No. 65-1 Core

Pl. 8, figs. 6, 7. Depth 445 to 449 feet; Edmonton Formation.
Pl. 8, figs. 6, 7. Slide No. I-50-17M; co-ord. 11.6/94.5.

Balmeisporites sp. A

Plate 9, figures 1-3

Description: Trilete megaspore; spore body circular in outline, with a coarsely reticulate surface; neck composed of three segments, finely pitted, approximately equal to or less than the body in diameter in length; exospore three layered; inner layer smooth about 4 microns thick; central layer finely pitted, 2 to 8 microns thick and with a reticulate pattern; lumina circular to subcircular, 5 to 15 microns wide; outer layer finely pitted, about 30 microns thick, ornamented by a broad reticulate pattern with lumina 30 to 55 microns in diameter and muri 2 to 8 microns wide; body with three equatorial extensions formed by the outer exospore layer, 40 to 50 microns wide.

Size range: Total length of megaspore (5 specimens) 200 to 320 microns.

Diameter of megaspore body (8 specimens) 150 to 240 microns.

Distribution: Edmonton Formation in R.C.A. No. 65-1 Core, section I ("zone" A); uppermost St. Mary River Formation

in outcrops along Oldman River north of Fort Macleod (figure 1).

Remarks: Balmeisporites sp. A differs from Balmeisporites dettmannii Srivastava and Binda, in press, in possessing larger lumina in both the central as well as the outer layer of exospore, and in the lack of gradation of the size of lumina in the outer exospore layer.

Locality of figured specimens: R.C.A. No. 65-1 Core

Pl. 9, figs. 1-3.	Depth 430 to 435 feet;	Edmonton Formation.
Pl. 9, figs. 1-3.	Slide No. I-49-1M;	co-ord. 8.9/79.7.

Balmeisporites sp. B

Plate 10, figures 1-3

Description: Trilete megaspore; spore body circular in outline, with a coarsely reticulate surface; neck composed of three segments, with a faint rib-like ornamentation, and shorter than the body diameter; exospore double-layered; inner layer smooth, 3 to 4 microns thick; outer layer ornamented by a reticulate pattern, lumina triagular, about 30 microns in diameter; muri smooth, often double walled, 3 to 4 microns wide, and 10 to 20 microns high; muri junctions crenulated and usually raised.

Size range: Total length of megaspore (3 specimens) 230 to 250 microns.

Diameter of megaspore body (4 specimens) 160 to 180 microns.

Distribution: Edmonton Formation in R.C.A. No. 65-1 Core, section I ("zone" A).

Locality of figured specimens: R.C.A. No. 65-1 Core

Pl. 10, figs. 1-3.	Depth 445 to 449 feet;	Edmonton Formation.
Pl. 10, figs. 1-3.	Slide No. I-50-3M;	co-ord. 5.5/86.9.

Balmeisporites sp. C

Plate 11, figure 3; plate 12, figures 1, 2

Description: Trilete megaspore; spore body circular in outline, with a coarsely reticulate surface; neck composed of three segments and shorter than body diameter; exospore three layered; inner layer smooth to faintly scabrate and 2 to 4 microns thick; central layer with a reticulate pattern, muri smooth, contorted, curved, about 12 microns thick and 2 to 3 microns wide forming irregular-shaped lumina; lumina 5 to 15 microns wide; outer layer ornamented by a broad reticulate pattern with larger lumina 20 to 50 microns in diameter, and about 30 microns high, formed by similarly contorted muri; body with three wing-like equatorial outgrowths formed by the outer exospore layer, 40 to 50 microns wide.

Size range: Total length of megaspore (2 specimens) 240 to 260 microns.

Diameter of megaspore body (4 specimens) 180 to 200 microns.

Distribution: Edmonton Formation in R.C.A. No. 65-1 Core, section I ("zone" A).

Locality of figured specimens: R.C.A. No. 65-1 Core

Pl. 11, fig. 3.	Depth 445 to 449 feet;	Edmonton Formation.
Pl. 11, fig. 3.	Slide No. I-50-4M;	co-ord. 14.3/71.5.
Pl. 12, figs. 1, 2.	Depth 445 to 449 feet;	Edmonton Formation.
Pl. 12, figs. 1, 2.	Slide No. I-50-4M;	co-ord. 14.3/71.5.

Balmeisporites sp. D

Plate 11, figures 1, 2

Description: Trilete megaspore; spore body circular in outline, with a ribbed surface; neck short with three segments; exospore double-layered; inner layer smooth; outer layer ornamented by fine-meshed reticulate pattern with lumina 1 to 2 microns wide; surface with converging ribs forming peaks 30 to 40 microns high, ribs smooth, 2 to 4 microns wide.

Size range: Total length of megaspore (5 specimens) 120 to 210 microns.

Diameter of megaspore body (10 specimens) 80 to 180 microns.

Distribution: Edmonton Formation in R.C.A. No. 65-1 Core, section I ("zone" A), and outcrop section III along the Red Deer River; uppermost St. Mary River Formation in

outcrops along the Oldman River north of Fort Macleod (figure 1).

Remarks: *Balmeisporites* sp. D is similar to *Balmeisporites bellus* Kondinskaya, 1966 and *Balmeisporites mollis* Kondinskaya, 1966 in possessing converging ribs which coalesce to form numerous peaks. Kondinskaya's species, however, have an outer exospore layer ornamented by fine granules instead of a fine-meshed reticulate pattern.

Locality of figured specimens: R.C.A. No. 65-1 Core

Pl. 11, figs. 1, 2.	Depth 445 to 449 feet;	Edmonton Formation.
Pl. 11, figs. 1, 2.	Slide No. I-50-6M;	co-ord. 10.7/73.4.

DIVISION PTERIDOPHYTA

CLASS FILICOPSIDA

FAMILY SALVINIACEAE

Genus *Azolla* Lamarck, 1783

Remarks: Figure 6 shows the general morphological components of the *Azolla* megaspores described in the present study. The megaspore body is circular in outline and covered with a dense perispore composed of two or more lamellae. A Y-shaped dehiscence mark is always visible on the megaspore wall and usually seen on the perispore. Above the Y-shaped mark a spongy mound provides a cushion-like columella which carries the three upper massulae or the "swimming

a - - - megaspore body

b - - - megaspore wall

c - - - perispore (lamellar)

d - - - y-shaped dehiscence mark

e - - - cushion-like columella

f - - - "swimming apparatus"

g - - - float-like structures

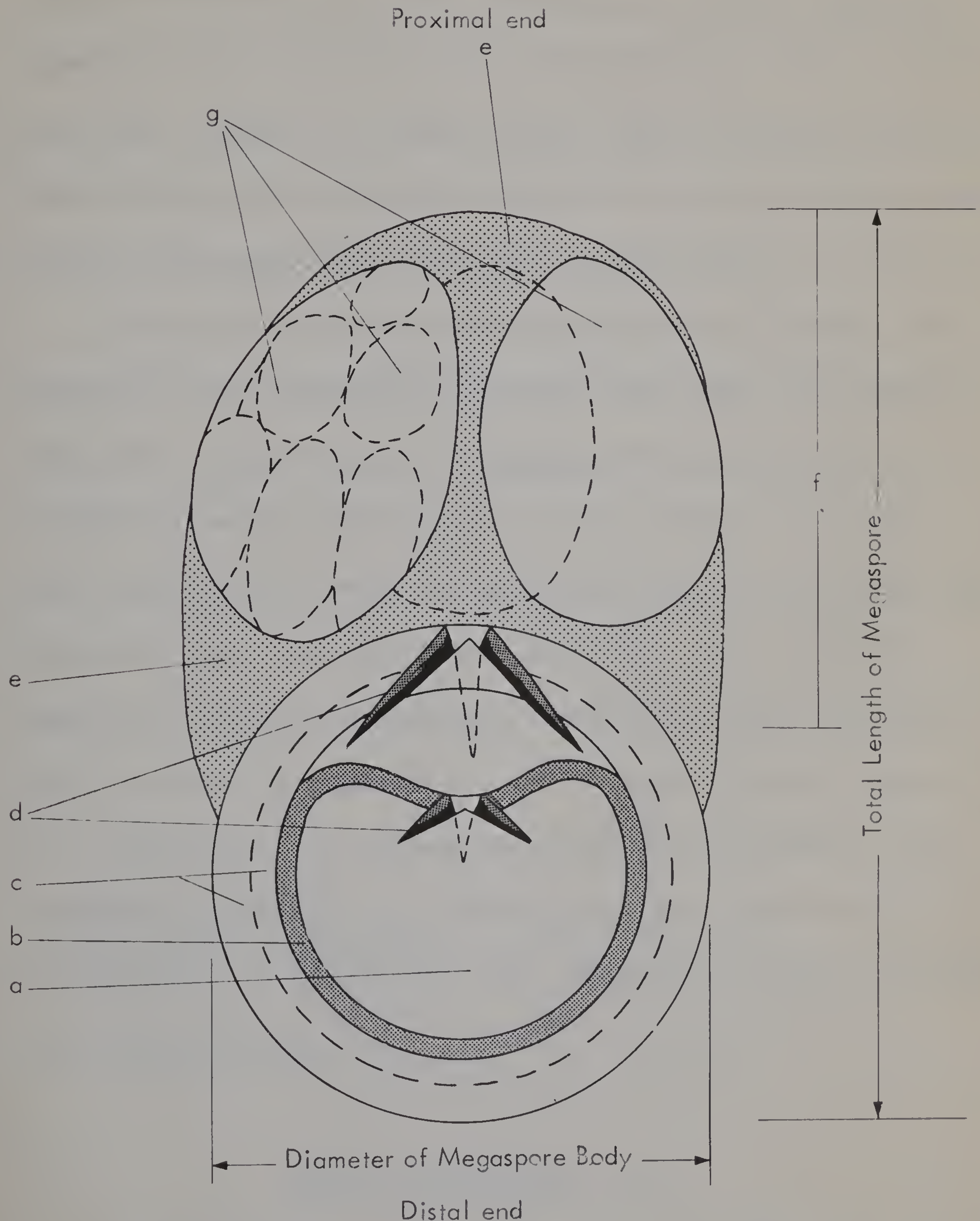

FIGURE 6. Azolla. Diagrammatic Representation of the General Morphology.

apparatus" (Eames, 1936). According to Hills (personal communication), this cushion-like mass extends upward, parallel to the Y-shaped dehiscence mark, and along three planes of original separation within the "swimming apparatus". A detailed discussion of the subdivision of the "swimming apparatus" into multifloated conditions is given by Hills and Gopal (1966). In this study, the end nearest the Y-shaped dehiscence mark is referred to as the proximal end, and the one away from it as the distal end.

To date, in almost every palynological study, the nature of the "swimming apparatus" has been the primary basis for classification of *Azolla* megaspores species. In the following descriptions a new approach is taken which lays more stress on the nature and structure of the megaspore wall and perispore lamellae. The "swimming apparatus" is not always well defined on every specimen, which limits the application of a classification based on it. Although it is recognized that the division of the "swimming apparatus" is genetically very significant, it is necessary to supplement this approach through the study of the wall structure.

Azolla distincta n. sp.

Plate 13, figures 1-4; plate 14, figures 1-3

Description: Outline of megaspore conical; "swimming apparatus" with numerous float-like structures; Y-shaped dehiscence mark distinct on megaspore wall and perispore; perispore composed of four lamellae; outer lamella 5 to 15 microns thick, consisting of filaments 1 to 2 microns in diameter; outer central lamella 7 to 10 microns thick, composed of a regular reticulate structure with 8 to 10 microns wide lumina; muri widen from 1 to 2 microns at the base to 2 to 5 microns at the top; outer central lamella supported by the inner central lamella consisting of a fine reticulate structure, 1 to 2 microns thick; inner lamella smooth, about 3 microns thick; megaspore wall faintly scabrate, 3 to 4 microns thick.

Size range: Total length of megaspore (50 specimens) 470 to 630 microns.

Diameter of megaspore body (75 specimens) 350 to 440 microns.

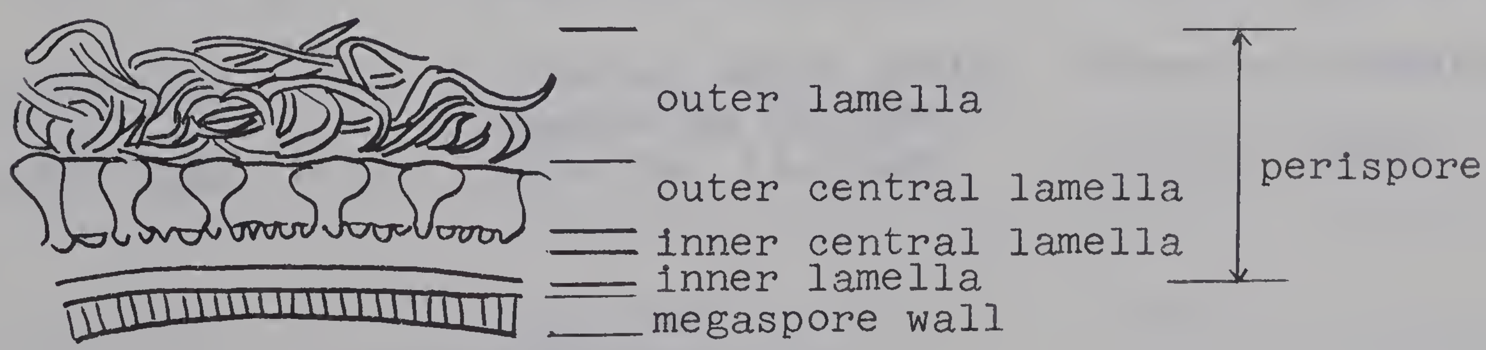

FIGURE 7. Azolla distincta n. sp. Crossection of Perispore and Megaspore Wall.

Distribution: Paskapoo and Edmonton Formations in R.C.A. No. 65-1 Core, section I ("zones" A, B, and C), and in outcrop sections II, III and IV on the Red Deer River; throughout Willow Creek Formation in southwestern Alberta (figure 1).

Remarks: The specific name is derived from "distinctus" (distinct).

The float-like structures were visible only when the "swimming apparatus" had been crushed or separated. No attempt was made to investigate the "swimming apparatus" in detail.

Locality of figured specimens: R.C.A. No. 65-1 Core, section II on the Red Deer River.

Holotype:		
Pl. 13, figs. 1, 4.	Depth 313 to 319 feet;	Edmonton Formation.
Holotype:		
Pl. 13, figs. 1, 4.	Slide No. I-40-8M;	co-ord. 4.4/77.7.
Pl. 13, fig. 2.	Interval above Ardley seam 84 to 87 feet;	Edmonton Formation.
Pl. 13, fig. 2.	Slide No. II-14-6M;	co-ord. 14/81.
Pl. 13, fig. 3.	Depth 143 to 150 feet;	Edmonton Formation.
Pl. 13, fig. 3.	Slide No. I-14-4M;	co-ord. 11.2/80.4.
Pl. 14, figs. 1-3.	Interval above Ardley seam 84 to 87 feet;	Edmonton Formation.
Pl. 14, figs. 1-3.	Slide No. II-14-6M;	co-ord. 14/81.

<u>Azolla</u> <u>filosa</u> n. sp.

Plate 15, figures 1-4

Description: Outline of megaspore oval to ellipsoidal;

"swimming apparatus" with numerous float-like structures; Y-shaped dehiscence mark distinct on megaspore wall and indistinct on perispore; perispore composed of two lamellae; outer lamella 16 to 20 microns thick, consisting of fine filaments, about 1 micron in width; outer lamella grading gradually into dense, smooth inner lamella, 6 to 8 microns thick; megaspore wall very finely granulate and 4 to 6 microns thick.

Size range: Total length of megaspore (10 specimens) 500 to 525 microns.

Diameter of megaspore body (10 specimens) 270 to 300 microns.

Distribution: Edmonton Formation in R.C.A. No. 65-1 Core, subsurface section I ("zones" A and B) and outcrop section III on the Red Deer River.

Remarks: The specific name is derived from "filosus" (full of threads). The number of float-like structures could not be determined accurately.

Locality of figured specimens: R.C.A. No. 65-1 Core

Holotype: Pl. 15, fig. 1.	Depth 286 to 291 feet;	Edmonton Formation.
Holotype: Pl. 15, fig. 1.	Slide No. I-34-11-2M;	co-ord. 12.5/81.2.
Pl. 15, fig. 2.	Depth 286 to 291 feet;	Edmonton Formation.
Pl. 15, fig. 2.	Slide No. I-34-6M;	co-ord. 11.3/107.
Pl. 15, figs. 3, 4.	Depth 286 to 291 feet;	Edmonton Formation.
Pl. 15, figs. 3, 4.	Slide No. I-34-6M;	co-ord. 11.7/94.2.

Azolla barbata n. sp.

Plate 16, figures 1-3; plate 17, figures 1, 2

Description: Outline of megaspore elongate-ellipsoidal; "swimming apparatus" with numerous indistinct float-like structures; Y-shaped dehiscence mark distinct on megaspore wall and perispore; perispore composed of three lamellae; outer lamella 10 to 15 microns thick consisting of a foveolate structure; foveae 8 to 10 microns wide and may or may not be occupied by a pore; areas between foveae 10 to 15 microns wide; outer lamella supported by a central lamella consisting of columellae 3 to 4 microns high and 1 to 2 microns in diameter; columellae fused in the area around the fovea; inner lamella about 5 microns thick and smooth; megaspore wall 3 to 4 microns thick, scabrate or possibly infragranulate.

Size range: Total length of megaspore (5 specimens) 450 to 500 microns.

Diameter of megaspore body (10 specimens) 270 to 350 microns.

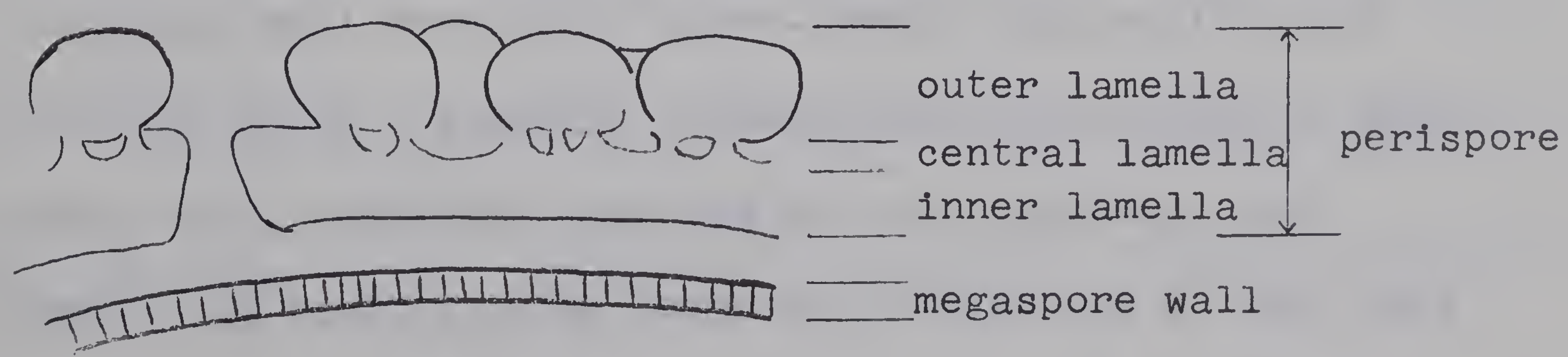

FIGURE 8. Azolla barbata n. sp. Crossection of Perispore and Megaspore Wall.

Distribution: Edmonton Formation in R.C.A. No. 65-1 Core, section I ("zone" A) and in outcrop section III on the Red Deer River; upper Willow Creek Formation in outcrop sections along Willow Creek, west of Granum, and along Oldman River north of Pincher Creek.

Remarks: The specific name is derived rom "barbatus" (bearded).

The number of float-like structures was not determined.

Locality of figured specimens: R.C.A. No. 65-1 Core

Holotype: Pl. 16, fig. 1.	Depth 286 to 291 feet;	Edmonton Formation.
Holotype: Pl. 16, fig. 1.	Slide No. I-34-14M;	co-ord. 93.3/12.6.
Pl. 16, figs. 2, 3.	Depth 286 to 291 feet;	Edmonton Formation.
Pl. 16, figs. 2, 3.	Slide No. I-34-11-1M;	co-ord. 8.2/79.4.
Pl. 17, figs. 1, 2.	Depth 286 to 291 feet;	Edmonton Formation.
Pl. 17, figs. 1, 2.	Slide No. I-34-14M;	co-ord. 93.3/12.6.

Azolla pilata n. sp.

Plate 17, figures 3, 4; plate 18, figures 1-4

Description: Outline of megaspore oval to circular; columella well developed, three-lobed, cushion-like and situated above a distinct Y-shaped dehiscence mark on megaspore wall; perispore composed of two lamellae; outer lamella up to 90 microns thick and consisting of very fine densely packed filaments less than 1 micron in diameter;

inner lamella 40 to 50 microns thick, dense, fibrous to cellular; megaspore wall smooth, 4 to 5 microns thick.

Size range: Total length of megaspore (7 specimens) 400 to 450 microns.

Diameter of megaspore body (7 specimens) 300 to 360 microns.

Distribution: Edmonton Formation in R.C.A. No. 65-1 Core, section I ("zone" B).

Remarks: The specific name is derived from "pilatus" (dense, thick, hairy). According to Hills (personal communication) the float-like structures have been removed from these specimens leaving numerous concave surfaces of attachments along the sides and proximal end of the megaspore (plate 17, figure 1).

Locality of figured specimens: R.C.A. No. 65-1 Core

Holotype: Pl. 17, fig. 1.	Depth 286 to 291 feet;	Edmonton Formation.
Holotype: Pl. 17, fig. 1.	Slide No. I-34-10-3M;	co-ord. 12/80.6.
Pl. 17, fig. 2.	Depth 286 to 291 feet;	Edmonton Formation.
Pl. 17, fig. 2.	Slide No. I-34-4M;	co-ord. 11.5/84.3.
Pl. 18, fig. 1.	Depth 286 to 291 feet;	Edmonton Formation.
Pl. 18, fig. 1.	Slide No. I-34-10-2M;	co-ord. 12.3/83.8.
Pl. 18, fig. 2.	Depth 286 to 291 feet;	Edmonton Formation.
Pl. 18, fig. 2.	Slide No. I-34-10-3M;	co-ord. 12/80.6.
Pl. 18, figs. 3, 4.	Depth 286 to 291 feet;	Edmonton Formation.
Pl. 18, figs. 3, 4.	Slide No. I-34-10-1M;	co-ord. 11/77.

Azolla conspicua n. sp.

Plate 19, figures 1, 2; plate 20, figures 1,2

Description: Outline of megaspore ellipsoidal; "swimming apparatus" with numerous float-like structures; Y-shaped dehiscence mark distinct on megaspore wall and indistinct on perispore; perispore composed of two lamellae; outer lamella 20 to 40 microns thick, consisting of coarse densely packed filaments 1 to 2 microns in diameter; outer lamella supported by a smooth to finely granulate inner lamella, 3 to 5 microns thick; megaspore wall 10 to 12 microns thick, very finely punctate or possibly infragranulate.

Size range: Total length of megaspore (5 specimens) 800 to 1000 microns.

Diameter of megaspore body (5 specimens) 460 to 520 microns.

Distribution: Edmonton Formation in R.C.A. No. 65-1 Core, section I ("zone" A) and uppermost St. Mary River Formation on Oldman River, Fort Macleod area.

Remarks: The specific name is derived from "conspicuus" (conspicuous).

Azolla conspicua n. sp. differs from similar species described in this study by having a much larger body diameter and thicker megaspore wall.

Locality of figured specimens: R.C.A. No. 65-1 Core

Holotype: Pl. 19, fig. 1.	Depth 476 to 481 feet;	Edmonton Formation.
Holotype: Pl. 19, fig. 1.	Slide No. I-52-2M;	co-ord. 12.5/72.5.
Pl. 19, fig. 2.	Depth 476 to 481 feet;	Edmonton Formation.
Pl. 19, fig. 2.	Slide No. I-52-2M;	co-ord. 20.3/76.
Pl. 20, figs. 1, 2.	Depth 476 to 481 feet;	Edmonton Formation.
Pl. 20, figs. 1, 2.	Slide No. I-52-2M;	co-ord. 20.3/76.

Azolla fistulosa n. sp.

Plate 20, figures 3, 4; plate 21, figures 1-3

Description: Outline of megaspore oval to ellipsoidal; "swimming apparatus" dense with indistinct float-like structures; Y-shaped dehiscence mark distinct on megaspore wall and indistinct on perispore; perispore composed of three lamellae; outer lamella 20 to 30 microns thick, consisting of closely packed fine filaments about 0.5 micron in diameter; outer lamella grading into a spongy central lamella 15 to 20 microns thick; cells of spongy lamella 2 to 15 microns in diameter; central lamella supported by a very thin smooth inner lamella 1 to 2 microns thick; megaspore wall 3 to 4 microns thick and faintly scabrate.

Size range: Total length of megaspore (10 specimens) 450 to 480 microns.

Diameter of megaspore body (10 specimens) 250 to 290 microns.

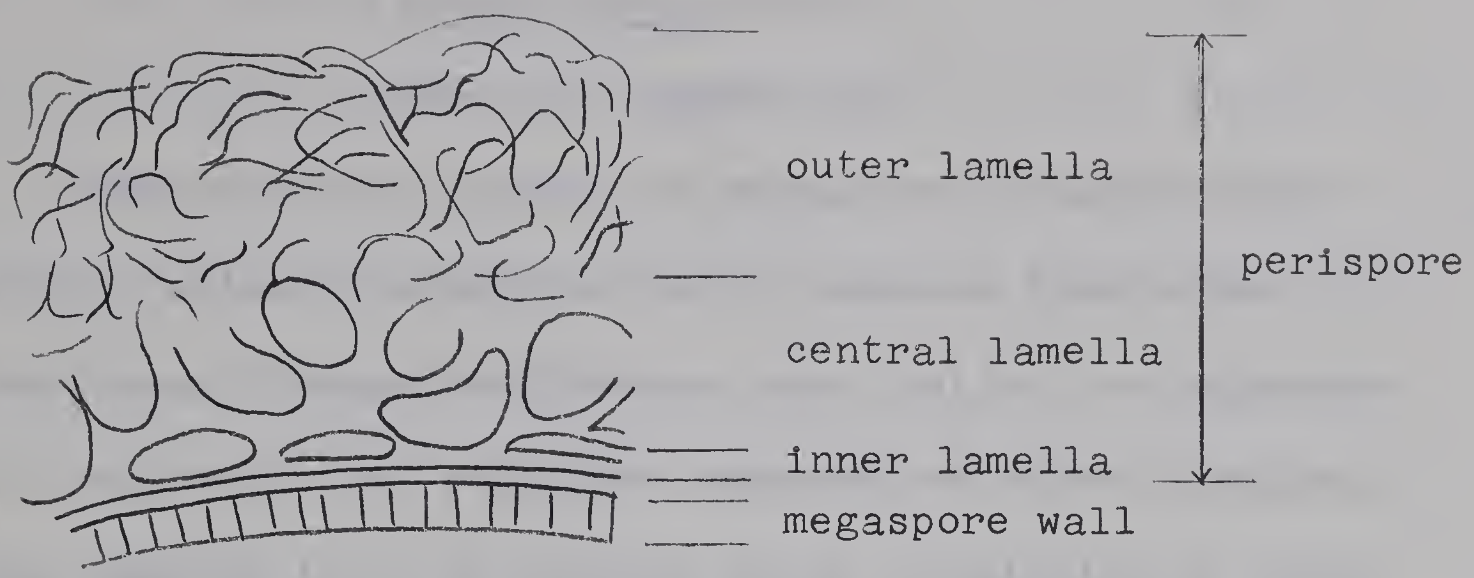

FIGURE 9. Azolla fistulosa n. sp. Crossection of Perispore and Megaspore Wall.

Distribution: Edmonton Formation in outcrop sections II and IV ("zone" B) on the Red Deer River.

Remarks: The specific name is derived from "fistulosus" (spongy).

Locality of figured specimens: Red Deer River outcrop sections II and IV

Holotype: Pl. 20, fig. 3.	Interval above Kneehills 150 to 155 feet;	Edmonton Formation.
Holotype: Pl. 20, fig. 3.	Slide No. IV-4-9M;	co-ord. 11/79.9.
Pl. 20, fig. 4.	Interval above Kneehills 150 to 155 feet;	Edmonton Formation.
Pl. 20, fig. 4.	Slide No. IV-4-5M;	co-ord. 8.4/80.1.
Pl. 21, figs. 1-3.	Interval above Kneehills 150 to 155 feet;	Edmonton Formation.
Pl. 21, figs. 1-3.	Slide No. IV-4-5M;	co-ord. 21.6/75.1.

<u>Azolla</u> <u>lauta</u> n. sp.

Plate 22, figures 1-4

Description: Outline of megaspore elongate-ellipsoidal; "swimming apparatus" with numerous float-like structures; Y-shaped dehiscence mark distinct on megaspore wall and perispore; perispore composed of three lamellae; outer lamella 10 to 20 microns thick, consisting of filaments approximately 1 micron in diameter; central lamella 6 to 8 microns thick consisting of fossulae-like grooves widening near their bases; grooves about 1 micron wide and 2 to 5 microns long; inner lamella 5 to 6 microns thick, smooth and dense; megaspore wall finely granular, 4 to 5 microns thick.

Size range: Total length of megaspore (25 specimens) 560 to 640 microns.

Diameter of megaspore body (50 specimens) 275 to 360 microns.

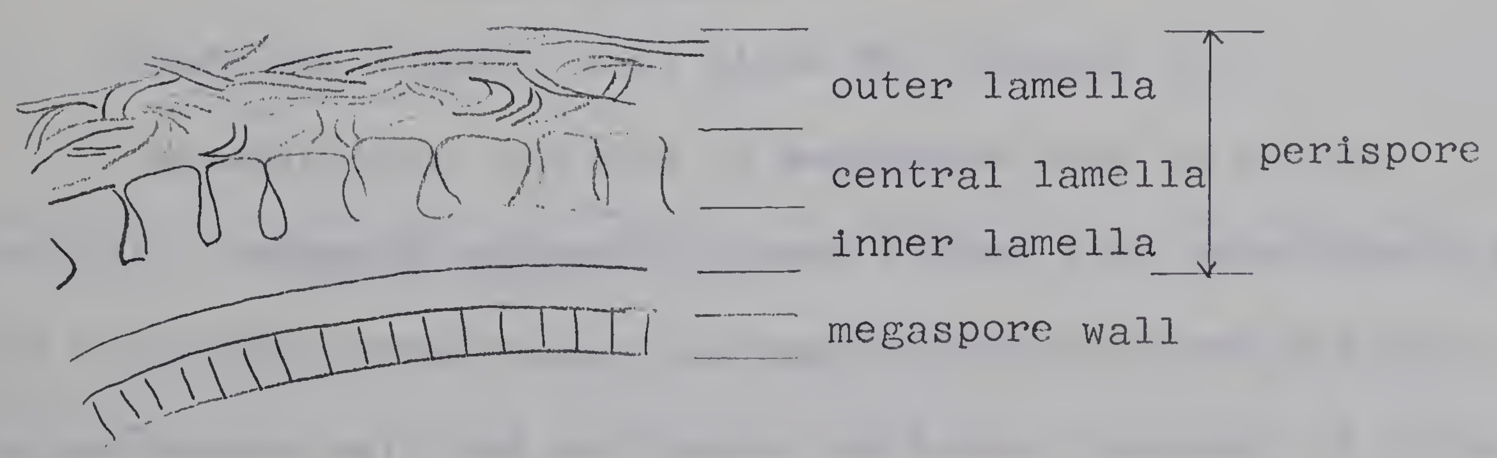

FIGURE 10. <u>Azolla</u> <u>lauta</u> n. sp. Crossection of Perispore and Megaspore Wall.

Distribution: Edmonton Formation in R.C.A. No. 65-1 Core, section I ("zones" A and B) and in outcrop section III on the Red Deer River; upper Willow Creek Formation in outcrop sections along Willow Creek west of Granum and along Oldman River north of Pincher Creek.

Remarks: The specific name is derived from "lautus" (neat, elegant).

The nature of the "swimming apparatus" and number of float-like structures were not investigated in detail.

Locality of figured specimens: R.C.A. No. 65-1 Core

Holotype:		
Pl. 22, fig. 1.	Depth 286 to 291 feet;	Edmonton Formation.
Holotype:		
Pl. 22, fig. 1.	Slide No. I-34-2M;	co-ord. 7.7/91.3.
Pl. 22, figs. 2, 3.	Depth 286 to 291 feet;	Edmonton Formation.
Pl. 22, figs. 2, 3.	Slide No. I-34-1-1M;	co-ord. 9.3/80.2.
Pl. 22, fig. 4.	Depth 286 to 291 feet;	Edmonton Formation.
Pl. 22, fig. 4.	Slide No. I-34-4M;	co-ord. 11.7/81.3.

<u>Azolla</u> <u>bulbosa</u> n. sp.

Plate 23, figures 1-4; plate 24, figures 1-3

Description: Outline of megaspore oval to ellipsoidal; "swimming apparatus" three tiered with approximately 18 float-like structures; Y-shaped dehiscence mark distinct on megaspore wall and perispore; perispore composed of three lamellae; outer lamella 6 to 12 microns thick and consisting

of an irregular reticulate structure with 5 to 15 microns wide lumina; muri 3 to 5 microns in width, expanding at junctions to form bulbous protrusions 8 to 12 microns in diameter; outer lamella supported by a central lamella composed of columellae approximately 1 micron in diameter and 1 to 2 microns high; inner lamella faintly granular, 3 to 5 microns thick; megaspore wall faintly scabrate or possibly smooth, 3 to 4 microns thick.

Size range: Total length of megaspore (15 specimens) 430 to 540 microns.

Diameter of megaspore body (15 specimens) 290 to 350 microns.

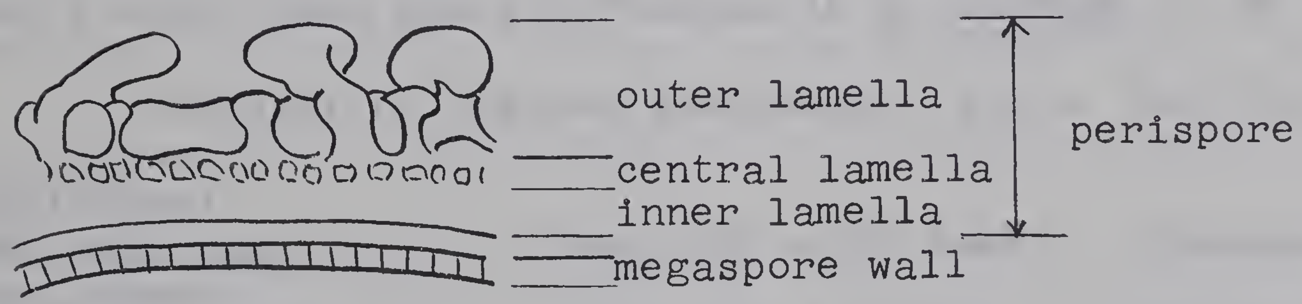

FIGURE 11. Azolla bulbosa n. sp. Crossection of Perispore and Megaspore Wall.

Distribution: Paskapoo Formation in R.C.A. No. 65-1 Core, section I ("zone" C).

Remarks: The specific name is derived from "bulbosus"

(bulbous) and refers to the bulbous protrusions on the perispore. The nature of the "swimming apparatus" and number of float-like structures were not investigated in detail. The size range and wall morphology of Azolla bulbosa are very similar to those of Azolla teschiana Florschütz, 1949. For comparison, plates 25 and 26 were prepared from specimens of A. teschiana loaned by L.V. Hills, U. of Calgary. Both A. bulbosa and A. teschiana show an irregular discontinuous reticulate structure with distinct protrusions on the perispore surface. A detailed analysis of the wall structure shows the protrusions in A. teschiana to be composed of outer lamella material surrounding a pore which arises from the inner lamella. This differs markedly from the simple bulbous muri which form the protrusions in A. bulbosa n. sp.

Locality of figured specimens: R.C.A. No. 65-1 Core

Holotype:

Pl. 23, fig. 1.	Depth 80 to 87 feet;	Paskapoo Formation.
Holotype:		
Pl. 23, fig. 1.	Slide No. I-8-1M;	co-ord. 14/76.
Pl. 23, fig. 2.	Depth 80 to 87 feet;	Paskapoo Formation.
Pl. 23, fig. 2.	Slide No. I-8-6M;	co-ord. 7.6/85.
Pl. 23, figs. 3, 4.	Depth 80 to 87 feet;	Paskapoo Formation.
Pl. 23, figs. 3, 4.	Slide No. I-8-21M;	co-ord. 16/84.
Pl. 24, figs. 1-3.	Depth 80 to 87 feet;	Paskapoo Formation.
Pl. 24, figs. 1-3.	Slide No. I-8-21M;	co-ord. 16/84.

Azolla schopfi Dijkstra, 1961

Plate 27, figures 1-3; plate 28, figures 1-3

1961 *Azolla schopfi* Dijkstra, Mededel. Geol. Sticht., n.s., no. 13, p. 9, pl. 2, figs. 42-49.

Description: Outline in longitudinal view oval; "swimming apparatus" three tiered with approximately 18 float-like structures; long axis of float-like structures in basal tier 80 to 100 microns and in central tier 50 to 60 microns; Y-shaped dehiscence mark distinct on the megaspore wall and perispore; perispore composed of three lamellae; outer lamella 5 to 9 microns thick, consiting of granules, verrucae and verrucae-rugulae; granules and verrucae densely packed, 3 to 6 microns in diameter and often coalescing to form a verrucate-rugulate structure; pore spaces 4 to 5 microns wide, randomly distributed through outer lamella; outer lamella supported by a central lamella of columellae about 1 micron in diameter and 1 to 2 microns high; inner lamella 6 to 12 microns thick, smooth, with distinct pore structures 2 to 3 microns in diameter; megaspore wall finely granulate, 3 to 4 microns thick.

Size range: Total length of megaspore (50 specimens) 475 to 525 microns.

Diameter of megaspore body (100 specimens) 290 to 350 microns.

Distribution: Paskapoo and Edmonton Formations in

R.C.A. No. 65-1 Core, section I ("zones" A, B, and C) and Edmonton Formation in outcrop sections II and III on the Red Deer River; uppermost Willow Creek Formation on Willow Creek west of Granum.

Fort Union Formation, Ludlow Member (Paleocene), South Dakota (Dijkstra, 1961).

Remarks: Plate 29 was prepared for Azolla schopfi Dijkstra, 1961, from specimens on loan from L.V. Hills, U. of Calgary, Calgary, Alberta. A. schopfi was described by Dijkstra as having at least 15 floats which compares very closely to the number of floats present on the specimens in this study. As can be seen by comparing plates 27, 28 and 29, the wall structures are almost identical.

Locality of figured specimens: R.C.A. No. 65-1 Core

Pl. 27, fig. 1.	Depth 229 to 236 feet;	Edmonton Formation.
Pl. 27, fig. 1.	Slide No. I-26-12M;	co-ord. 13.9/82.6.
Pl. 27, figs. 2, 3.	Depth 142 to 147 feet;	Edmonton Formation.
Pl. 27, figs. 2, 3.	Slide No. I-14-1M;	co-ord. 13.6/83.2.
Pl. 28, figs. 1-3.	Depth 142 to 147 feet;	Edmonton Formation.
Pl. 28, figs. 1-3.	Slide No. I-14-1M;	co-ord. 13.6/83.2.

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APPENDIX

MEASURED SECTIONS

Section: cored section of lowermost Paskapoo Formation and uppermost Edmonton Formation (section I).

Location: R.C.A. No. 65-1 Core, about 25 miles southwest of Edmonton, Lsd. 4, Sec. 8, Tp. 48, R. 27, W. 4th Me. (figures 1, 2).

Thickness of bed in feet	Total depth in feet	Lithology
		PASKAPOO FORMATION
2	15.2	siltstone, yellowish to buff, blocky fracture, yellowish-brown coating along fractures.
1	16.2	siltstone, light grey, blocky fracture, yellowish-brown coating along fractures.
5	21.2	interbedded sandstone and siltstone, yellowish-grey, friable, carbonaceous laminations, yellowish-brown coating along fractures.
1.7	22.9	claystone grading to siltstone near bottom, grey, blocky fractures, yellowish-brown coating along fractures.
13.5	36.4	claystone, grey, homogeneous, moderately consolidated, blocky fracture.
1.6	38	claystone, light grey to grey, hard.
2.45	40.45	siltstone, yellowish-grey to grey, blocky fracture, yellowish-brown coating along fractures.
4	44.45	sandstone, medium-grained, grey.
6.3	50.75	siltstone, grey to black, blocky fracture, carbonaceous and sandy near bottom.

0.4	51.15	sandstone, fine- to medium-grained, grey, yellowish-brown coating along fractures, hard to friable.
2.5	53.65	siltstone, argillaceous, bluish-grey, blocky fracture.
0.5	54.15	sandstone, medium-grained, grey.
6.1	60.25	siltstone, shaly, bluish-grey, blocky fracture.
5.97	66.22	claystone, alternating layers of grey, greenish-grey, brownish-grey and yellowish-green, slightly fissile, carbonaceous near top.
1	67.22	sandstone, light grey, thin-bedded.
6.4	73.62	claystone, sandy, mottled greenish-grey, less sandy and more consolidated near bottom.
1	74.62	sandstone, shaly, greenish-grey.
5.4	80.02	sandstone, fine- to medium-grained, laminated carbonaceous.
15	95.02	claystone, greenish-grey, carbonaceous, varved and somewhat silty near center.
5.8	100.82	siltstone, grey to light grey, cross-laminated near bottom.
4.5	105.32	siltstone, argillaceous, mottled grey and light brown, increasingly argillaceous near bottom.
4.5	109.82	sandstone, silty, grey, finely-laminated, less silty and mottled grey and yellowish-brown near bottom.
2.1	111.92	sandstone, medium-grained, grey, even textured.

1.6	113.52	sandstone, medium-grained, grey, laminated, carbonaceous, soft.
6.45	119.97	sandstone, silty, grey, homogeneous, moderately consolidated.
0.35	120.32	sandstone, medium-grained, finely laminated, hard.
5	125.32	sandstone, medium- to coarse-grained, grey, some orangish-brown coatings along fractures (poor core recovery).
2.5	127.82	sandstone, medium- to coarse-grained, very carbonaceous, few shale stringers, two bands of claystone fragments along with several large megafossils.
0.7	128.52	sandstone, medium- to coarse-grained, homogeneous.
5.33	133.85	sandstone, medium- to coarse-grained, grey to bluish-grey, abundant light brown to bluish-green claystone pebbles, carbonaceous, some Unio type megafossils near top.
1.2	135.05	siltstone, grey to yellowish-grey, finely laminated, some carbonaceous material.
0.8	135.85	sandstone, fine- to medium-grained, grey, carbonaceous, some cross-bedding.
1.7	137.55	siltstone, grey, hard, some cross-laminations, grading from sandy near top to argillaceous, near bottom.
3.3	140.85	claystone, yellowish-grey to buff, blocky fracture.

EDMONTON FORMATION

0.8	141.65	claystone, silty, grey to light purple, fractures at all angles, very hard.
0.5	142.15	claystone, dark brown, bituminous, hard.
0.8	142.95	lignite, with few claystone and siltstone stringers.
0.6	143.55	claystone, purplish-brown, with some coal.
2.3	145.85	coal.
1.5	147.35	siltstone, sandy, bluish-brown, very carbonaceous.
1.40	148.75	claystone, dark grey to black, bituminous.
0.5	149.25	siltstone and coal intermixed.
0.5	149.75	claystone, light grey.
0.3	150.05	bituminous lignite.
0.65	150.70	claystone, purplish-brown, very hard, carbonaceous.
0.3	151	claystone, greenish-grey.
2	153	lignite, coal and black colored claystone.
4	157	claystone, dark greenish-grey, interbedded with carbonaceous material, few coal stringers.
4.5	161.5	coal.
1	162.5	silty claystone, light grey, hard, carbonaceous.
2.5	165	coal.

0.9	165.9	claystone, greenish-grey, blocky fracture, hard, carbonaceous.
0.2	166.1	claystone, very light grey, blocky fracture, soft.
1	167.1	claystone, greenish-grey, blocky fracture, hard, carbonaceous.
5.5	172.6	shale, grey to dark grey, fissile, shaly partings.
4	176.6	sandstone, silty, fine-grained light grey to buff, finely laminated.
5.5	182.1	coal, argillaceous.
1.3	183.4	siltstone, sandy, grey, coal stringers throughout.
0.6	184	siltstone, grey, hard.
0.3	184.3	sandstone, fine-grained, grey.
2.3	186.6	siltstone, sandy, grey, cross-laminated.
0.8	187.4	sandstone, fine-grained, grey, laminated.
1.5	188.9	siltstone, grey, friable.
1	189.9	sandstone, grey, hard, laminated, some yellowish-brown coatings along fractures.
4.2	194.1	siltstone, sandy to argillaceous, grey, carbonaceous stringers parallel to bedding, yellowish-red at bottom.
0.6	194.7	siltstone, argillaceous, hard, few carbonaceous stringers.
1.5	196.2	sandstone, silty, grey, laminated.

3.4	199.6	sandstone, medium-grained, grey, yellowish-brown mottled, laminated at base and top.
2	201.6	siltstone, grey to greenish-grey, finely laminated, blocky fracture, scattered carbonaceous fragments.
0.3	201.9	siltstone, buff, calcareous, very hard, carbonaceous.
0.4	202.3	claystone, dark grey, carbonaceous, coal stringers near base.
0.4	202.7	sandstone, medium- to fine-grained, light grey.
0.6	203.3	siltstone, interlaminated with fine-grained sandstone, grey, abundant plant remains, coal stringer near bottom.
1.7	205	siltstone, sandy, laminated, soft, last few inches yellowish-brown, calcareous.
1.4	206.4	siltstone, sandy, buff to grey, hard, local concentrations of reddish-brown.
0.9	207.3	sandstone, fine- to medium-grained, green to grey, finely laminated.
0.6	207.9	sandstone, silty, mottled grey to yellowish-brown, laminated, some carbonaceous material.
0.8	208.7	sandstone, medium-grained, grey, moderately consolidated, homogeneous.
1	209.7	siltstone, orangish-brown, hard.
1	210.7	sandstone, silty, grey, laminated.
2.25	212.95	siltstone, dark grey, laminated, argillaceous near bottom.

5	217.5	sandstone, fine- to medium-grained, light grey, crossbedded near top, coarser-grained near bottom.
0.75	218.25	siltstone, light buff to grey.
0.55	218.8	sandstone, medium-grained, light grey to dark grey, laminated.
0.66	219.46	siltstone and silty sandstone, light tan to grey, hard.
4	223.46	claystone, silty, grey.
5.5	228.96	claystone, grey, orangish-brown stringers.
0.8	229.76	siltstone, argillaceous, dark grey, carbonaceous.
0.75	230.51	claystone, dark grey to black, carbonaceous.
1	231.51	claystone, light grey, some carbonaceous material, few calcareous orangish-brown nodules.
0.59	232.1	coal.
2.5	234.6	siltstone, light grey to dark grey, slightly carbonaceous.
1.2	235.8	sandstone, fine-grained, abundant carbonaceous material.
4.5	241.3	sandstone, grey, laminated, some crossbedding, moderately consolidated.
3	244.3	siltstone, buff to grey, blocky fracture, hard, slightly carbonaceous.
1.5	245.8	sandstone, silty, light grey to dark grey, laminated.
2.7	248.5	siltstone, buff to grey, hard, few leaf imprints.

2	250.5	sandstone, medium- to coarse-grained, light grey, homogeneous.
0.2	250.7	siltstone, sandy, grey, carbonaceous.
0.9	251.6	sandstone, dark grey to brown, crossbedded, soft.
1.2	252.8	alternating layers of light grey to grey sandstone and dark grey to brown siltstones.
0.5	253.3	siltstone, dark brownish-grey to yellowish-buff.
0.2	253.5	sandstone, finely laminated.
0.4	253.9	sandstone, medium- to coarse-grained, light grey, homogeneous.
0.4	254.3	siltstone, brown.
0.3	254.6	sandstone, silty, brownish-grey, laminated to crossbedded, abundant carbonaceous material.
1.4	256	sandstone, medium- to coarse-grained, light grey, finely bedded, soft.
0.6	256.6	sandstone, silty, brownish-grey to buff, crossbedded, hard.
1	257.6	siltstone, sandy, brownish-grey, crossbedded, soft.
0.4	258	sandstone, grey to dark grey, crossbedded.
6	264	claystone, silty, grey, shaly partings, scattered thin hard orangish-brown layers.
4.3	268.3	claystone, silty, black, very carbonaceous, hard.
4.3	272.6	coal, argillaceous.

0.8	273.4	claystone, white, very hard.
1.3	274.7	coal.
0.5	275.2	siltstone, brown to purple.
1.1	276.3	coal.
3.3	279.6	siltstone, mottled greenish-grey to grey, blocky fracture, very hard.
0.7	280.3	sandstone, fine- to medium-grained, light grey.
2.1	282.4	siltstone, grey to greenish-grey, numerous stringers of orangish-brown material, hard.
0.9	283.3	sandstone, silty, greenish-grey, some orangish-brown concentrations.
0.5	283.8	siltstone, argillaceous, laminated, grey to dark grey, shaly partings.
0.5	284.3	sandstone, silty to argillaceous, light green, friable.
1.5	285.8	sandstone, medium-grained, greyish-green, carbonaceous.
0.2	286	lignite.
2.5	288.5	siltstone, argillaceous, greenish-grey.
2.4	290.9	claystone, silty, dark grey, blocky fracture.
2.6	293.5	siltstone, buff to green, very finely laminated, some carbonaceous material.
0.5	294	sandstone, silty, light green, some argillaceous inclusions.
0.4	294.4	siltstone, light green.

0.6	295	sandstone, silty, light green, some argillaceous inclusions.
0.25	295.25	sandstone, medium- to fine-grained, grey.
0.75	296	siltstone, green, argillaceous stringers.
2.2	298.2	sandstone, fine- to medium-grained, grey to greenish-grey, finely laminated near top.
2.3	300.5	siltstone, greenish-grey, carbonaceous, hard.
2.5	303	siltstone, light green, small green subrounded claystone inclusions.
4	307	siltstone, sandy, light brownish-grey, very hard.
5	312	siltstone, light green, laminated, blocky fracturing.
1.33	313.33	sandstone, medium-grained, grey, containing rounded clay granules.
0.8	314.13	shale, green, shaly partings.
0.4	314.53	shale, brownish-grey, silty toward bottom with distinct shaly partings.
4.47	319	sandstone, silty to argillaceous.
1.3	320.3	sandstone, medium-grained, light grey.
1.1	321.4	siltstone, greenish-grey, hard.
14.1	335.5	alternating layers of light grey and dark brown bentonitic claystone, numerous spherical inclusions of bentonite.

0.6	336.1	tuff, silicified, grey.
21.9	358	claystone, bentonitic, alternating intervals of light grey and dark brown, prominent shaly partings.
4	362	siltstone, light brown to grey, hard bentonitic stringers.
4.4	366.4	siltstone, buff colored, laminated.
2.6	369	sandstone, medium-grained, grey, with inclusions of large yellowish-green claystone pebbles.
29.8	398.8	sandstone, medium- to coarse-grained, greenish-grey, homogeneous, lack of distinct bedding, moderately consolidated.
12.7	411.5	sandstone, coarse-grained, grey, friable.
2	413.5	sandstone, medium-grained, hard, calcareous.
16	429.5	sandstone, coarse-grained, grey, friable, homogeneous.
0.5	430	shale, dark brownish-grey, carbonaceous.
1	431	siltstone, argillaceous, light green, hard, some carbonaceous stringers.
3	434	siltstone, sandy to argillaceous, light green, orange speckled, hard, calcareous.
1.5	435.5	siltstone, argillaceous, light green, hard, some carbonaceous material.
2.5	438	sandstone, silty, fine- to medium-grained, brownish-grey, laminated, soft.

Section: composite outcrop section of the lowermost Paskapoo Formation and the uppermost Edmonton Formation (Section II).

Location: Red Deer River, Ardley region, in Tp. 38, R. 23, W. 4th Mer.

Thickness of bed in feet	Total thickness in feet	Lithology
		Sec. 17, Tp. 38, R. 23, W. 4th Mer.
		PASKAPOO FORMATION
10	10	sandstone, medium- to coarse-grained, grey, small yellowish-brown concentrations make up approximately 10% of the matrix, yellowish-brown weathering surface.
		EDMONTON FORMATION
1	11	siltstone, orangish-red, very hard.
1	12	siltstone, light grey.
1	13	coal.
5	18	claystone, silty, dark grey, laminated.
2	20	interbedded dark lignitic shale and dark green to grey claystone.
7.5	27.5	siltstone, light green to grey, blocky fracturing, dark orangish-brown coating along fractures near bottom.
7	34.5	sandstone, medium-grained, grey orangish-brown coating along fractures and parallel to bedding, laminated in part.

2.5	469	sandstone, medium-grained, grey, cross-laminated.
2	471	sandstone, coarse-grained, soft, numerous carbonaceous stringers parallel to bedding.
2.6	473.6	coal.
0.4	474	claystone, white, mica flaked.
2	476	sandstone, fine- to medium-grained, grey.
5	481	claystone, greenish-grey, shaly partings, hard.
7	488	sandstone, light grey, few laminations, soft.
4.5	492.5	sandstone, medium- to coarse-grained, light grey, hard, carbonate cement.
4.1	496.6	siltstone, greenish-grey, carbonaceous, becoming sandy near bottom.
5.9	502.5	sandstone, medium-grained, laminated to cross-laminated, numerous lenses of orangish-brown calcareous siltstone.
2.5	505	siltstone, sandy, grey to dark grey.
1	506	coal.

Accurate measurements of depth in feet were recorded on each core box at the R.C.A. No. 65-1 boring location.

0.6	438.6	claystone, dark brown to dark grey, carbonaceous.
2.4	441	sandstone, silty, grey mottled, laminated.
0.3	441.3	claystone, greenish-grey, dense, blocky fracture.
3.3	444.6	sandstone, fine- to medium-grained, grey, laminated near top.
2.4	447	siltstone, argillaceous, dark brown, carbonaceous, few light green claystone pebbles near base.
2.2	449.2	siltstone, sandy, greenish-grey, laminated.
2.3	451.5	sandstone, fine- to medium-grained, grey.
2	453.5	coal, argillaceous and silty.
0.2	453.7	siltstone, very light grey, calcareous.
1	454.7	claystone, silty, light green.
1.1	455.8	siltstone, argillaceous, greenish-grey, blocky fracture, hard, abundant carbonaceous material.
1.2	457	sandstone, medium-grained, grey, laminated and crossbedded.
2.5	459.5	sandstone, grey, few orange clay-stone inclusions.
2.5	462	sandstone, medium-grained, grey, cross-laminated.
4.5	466.5	sandstone, silty, grey, cross-laminated, few orange claystone inclusions.

2.5	37	siltstone, grey, orangish-brown concentrations along fractures, laminated.
2	39	claystone, grey.
2	41	siltstone, brown, blocky-fracture.
0.5	41.5	sandstone, fine-grained, grey.
4	45.5	claystone, silty, greenish-grey.
1	46.5	claystone, silty, purple to green.
0.25	46.75	coal.
0.25	47	claystone, green.
3	50	siltstone, greenish-grey, orangish-brown concentrations along fractures.
4	54	sandstone, medium-grained, yellowish-grey.
0.5	54.5	claystone, dark grey.
0.5	55	sandstone, grey, orangish-brown coatings along fractures.
1	56	coal.
0.5	56.5	claystone, dark grey.
0.5	57	lignite.
1	58	claystone, dark grey, carbonaceous.
3.5	61.5	sandstone, fine- to medium-grained, grey, orangish-brown coatings along fractures.
0.5	62	siltstone, grey to orangish-brown, hard.
1	63	claystone, silty, grey.

5.5	68.5	sandstone, fine- to medium-grained, grey, laminated, orangish-brown concentrations throughout.
1	69.5	siltstone, sandy, grey, finely laminated.
1	70.5	coal.
2.5	73	claystone, silty, dark grey.
1	74	siltstone, brown, blocky fracture.
0.5	74.5	siltstone, orangish-red, hard.
1	75.5	sandstone, grey, soft.
6.5	82	claystone, mottled dark grey to yellowish-green, carbonaceous near bottom.
2.5	84.5	siltstone, sandy, yellowish-green.
1	85.5	sandstone, grey, orangish-brown concentrations.
8.5	94	(covered interval)
2.5	96.5	claystone, green.
1	97.5	siltstone, yellow-red, hard.
4	101.5	claystone, dark grey, blocky fracture, orangish-brown coatings along fractures.
3.5	105	claystone, light green
13	118	coal. (Ardley seam)

Sec. 35, Tp. 38, R. 23, W. 4th Mer.

EDMONTON FORMATION

5	5	claystone, grey.
3	8	sandstone, fine-grained, nodular.

2.5	10.5	sandstone, fine- to medium-grained, hard.
6	16.5	claystone, silty, buff to grey.
10	26.5	sandstone, fine-grained, buff to grey, nodular.
3.5	30	claystone, yellowish-grey, nodular.
28	58	claystone, silty, yellowish-grey.
12	70	claystone, dark purplish-grey, bentonitic (Mauve shale).
0.7	70.7	tuff, silicified, light grey (Kneehills Tuff).
15	85.7	claystone, dark purplish-grey, bentonitic (Mauve shale).
10	95.7	sandstone, fine- to medium-grained, white.

Section: outcrop section of the uppermost Edmonton Formation (section III).

Location: Red Deer River, Caprona region, in Sec. 17, Tp. 36, R. 21, W. 4th Mer., east side of river.

Thickness of bed in feet	Total thickness in feet	Lithology
3	3	coal.
4	7	sandstone, medium- to coarse-grained, grey, buff weathering surface.
5	12	claystone, silty, passing from dark grey to purple near top, light green near the base.
1.5	13.5	sandstone, fine- to medium-grained, very hard, buff weathering surface.
5	18.5	sandstone, fine- to medium-grained, grey, soft.
1.5	20	sandstone, fine-grained, dark brown to purple, finely laminated, very carbonaceous.
4	24	sandstone, medium-grained, grey.
1	25	claystone, silty, yellowish-grey.
1	26	claystone, silty, dark grey.
1.5	27.5	siltstone, light yellowish-green.
1.5	29	claystone, silty, dark grey to yellowish-grey.
3	32	siltstone, sandy, buff to yellowish-grey.
5	37	claystone, silty, greenish-grey.

3	40	siltstone, sandy, buff weathering surface.
1	41	sandstone, fine-grained, orangish-brown, very hard, crossbedded.
7	48	sandstone, medium-grained, grey, soft.
4	52	claystone, silty, light yellowish-green to grey.
3	55	sandstone, fine- to medium-grained, light yellowish-green.
4	59	claystone, silty, dark grey to purple.
1.5	60.5	siltstone, light yellowish to buff.
2.5	63	claystone, silty, dark grey.
3	66	sandstone, fine-grained, grey, buff weathering surface, very hard.
7	73	sandstone, medium-grained, grey, soft.
11	84	claystone, silty, yellowish to grey.
1	85	claystone, dark grey.
2	87	claystone, silty, light grey to yellow.
5	92	claystone, silty, purplish-grey.
7	99	sandstone, medium-grained moderately consolidated.
1	100	sandstone, fine- to medium-grained, yellowish-buff to brown, very hard, calcareous.
10	110	sandstone, medium-grained, grey, moderately consolidated.
9	119	claystone, silty, dark purplish-grey (Mauve shale).
1	120	tuff, siliceous, hard (Kneehills Tuff).

Section: outcrop section of the lowermost Paskapoo Formation and the uppermost Edmonton Formation (section IV).

Location: Red Deer River, Huxley region, Sec. 13, Tp. 34, R. 22, W. 4th Mer.

Thickness of bed in feet	Total thickness in feet	Lithology
	PASKAPOO FORMATION	
17	17	sandstone, medium- to coarse-grained, grey, buff weathered surface, crossbedded.
4	21	claystone, silty, buff to grey.
13	34	sandstone, fine- to medium-grained, grey, buff weathered surface, some crossbedding, carbonaceous near base.
	EDMONTON FORMATION	
5	39	claystone, silty, light grey to buff, carbonaceous.
6	45	claystone, light grey, homogeneous.
4	49	claystone, silty, light grey to buff, carbonaceous.
5	51	claystone, grey to dark grey, carbonaceous.
8	59	coal.
15	74	claystone, slightly silty, grey, carbonaceous, blocky fracture.
5	79	sandstone, fine- to medium-grained, grey, hard.

7	86	sandstone, fine-grained, light grey, argillaceous.
15	101	claystone, silty, grey to dark grey, slightly carbonaceous.
5	106	siltstone, buff to grey.
14	120	claystone interbedded with siltstones, carbonaceous.
1	121	lignite, very argillaceous, dark grey to black.
20	141	sandstone, medium-grained, grey, loosely consolidated.
50	191	(covered interval)
4	195	claystone, grey to purplish-grey.
10	205	sandstone, medium-grained, light grey, yellowish-brown weathering surface.
18	223	sandstone and siltstone interbedded, few nodules, numerous orangish-brown concentrations along bedding planes.
12	235	sandstone, medium-grained, light grey, yellow-brown weathering surface, hard.
2	237	claystone, silty, dark purplish-grey (Mauve shale).
0.5	237.5	tuff, siliceous, hard (Kneehills Tuff).
10.5	248	claystone, silty, dark purplish-grey (Mauve shale).
10	258	sandstone, fine-grained, white, argillaceous.

EXPLANATION OF PLATE 1

Edmonton Formation

"zone" A

Central Alberta

Magnification X1000

Figure 1: *Aquilapollenites polaris* Funkhouser; equatorial view, I-50-1.

Figures 2, 3: *Aquilapollenites reticulatus* Stanley; 2—equatorial view, body reticulation, III-9-1; 3—equatorial view, mid-focus, I-52-1.

Figure 4: *Leptolepidites tenuis* Stanley; mid-focus, I-51-1.

Figure 5: *Erdtmanipollis pachysandroides* Kurtzsch; high-focus, I-49-1.

Figure 6: *Aquilapollenites amplus* Stanley; equatorial view, I-40-3.

Figure 7: *Schizosporis complexus* Stanley; high-focus, I-50-1.

Figure 8: *Salixipollenites* sp. cf. *Tricolpites bathyreticulatus* Stanley; polar view, high-focus, I-52-1.

Figure 9, 10: *Aquilapollenites reductus* Norton; 9—equatorial veiw showing equatorial protrusions; 10—equatorial view showing polar protrusions: I-50-2.

PLATE 1

EXPLANATION OF PLATE 2

Edmonton Formation

"zone" A

Central Alberta

Magnification X1000

Figure 1: Aquilapollenites reductus Norton; equatorial view showing body reticulation, I-52-1.

Figure 2: Equisetosporites amabilis Srivastava; longitudinal view, I-52-1.

Figures 3, 4: Sigmopollis hispidus Hedlund; 3—mid-focus, I-34-1; 4—high-focus showing sigmoidal shaped aperture, I-52-1.

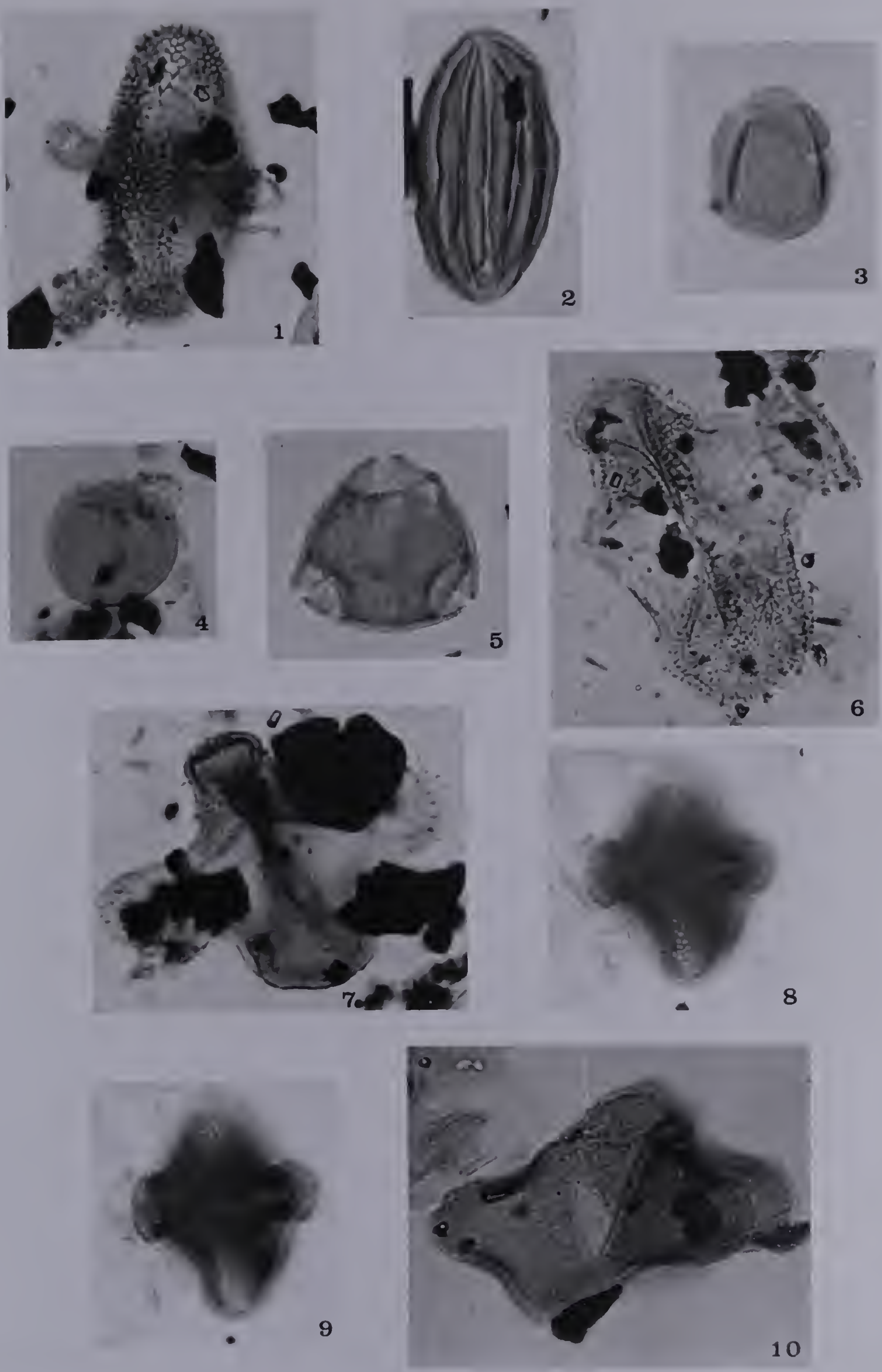
Figure 5: Symplocoipollenites vestibulum (Potonié) Potonié; mid-focus, I-50-2.

Figures 6, 7: Aquilapollenites sp. cf. A. attenuatus Funkhouser; 6—equatorial view showing fine reticulation; 7—equatorial view showing spinules: I-51-1.

Figures 8, 9: Aquilapollenites sp. C; 8—equatorial view, high-focus showing equatorial protrusions with striatoreticulate pattern; 9—equatorial view showing demicolpi: I-50-3.

Figure 10: Aquilapollenites sp. A; equatorial view, I-50-1.

PLATE 2



EXPLANATION OF PLATE 3

Edmonton Formation

"zone" A

Central Alberta

Magnifications X1000

Figures 1, 2: Hamulatisporis hamulatis Krutzsch; 1—proximal view; 2—distal view: I-51-1.

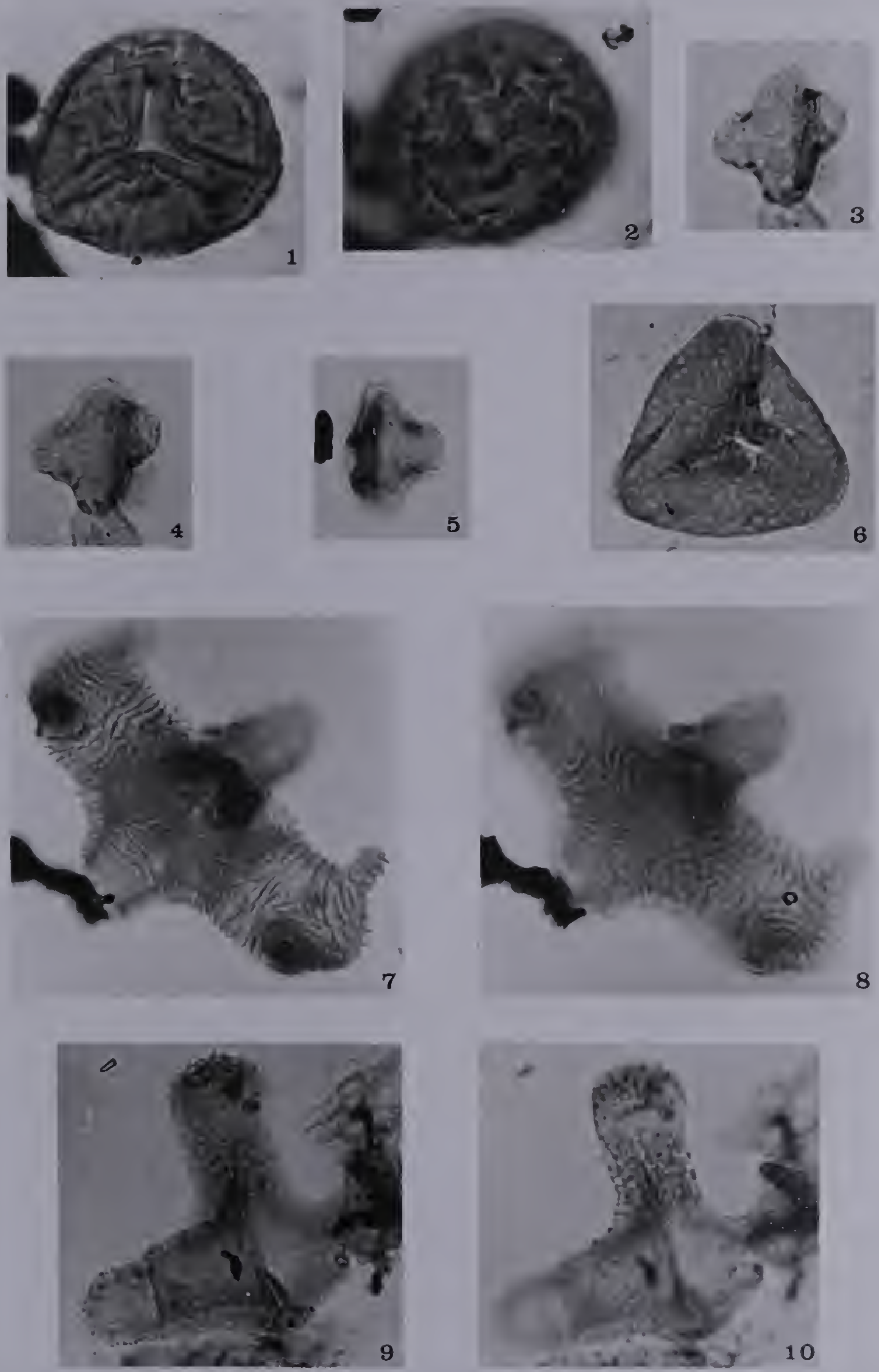
Figures 3, 4, 5: Aquilapollenites sp. B; 3—equatorial view showing polar protrusions and demicolpi; 4— equatorial view showing equatorial protrusions with spinules; 5—equatorial view showing spinules and demicolpi: I-40-3.

Figure 6: Dictyophyllidites sp.;proximal view, I-50-1.

Figures 7, 8: Aquilapollenites conatus; 7—equatorial view showing body and polar protrusions; 8—equatorial view showing equatorial protrusion with fine striations: I-34-2.

Figures 9, 10: Aquilapollenites delicatus Stanley; 9—equatorial view showing body reticulation; 10—equatorial view showing clavae: I-34-2.

PLATE 3



EXPLANATION OF PLATE 4

Edmonton Formation

"zone" A

Central Alberta

Magnification X1000

Figure 1: *Kurtzipites trispissatus* Anderson; polar view, I-40-3.

Figure 2: *Momipites sanjuanensis* Anderson; polar view, mid-focus, I-34-2.

Figures 3-5: *Wodehousia spinata* Stanley; 3—dorso-ventral view, III-1-1; 4—dorso-ventral view, III-1-1; 5—dorso-ventral view, I-40-3.

Figures 6-8: *Aquilapollenites* sp. cf. *A. quadricretaceus* Chlonova; 6—equatorial view showing clavate pattern on polar protrusions; 7—equatorial view showing equatorial protrusions; 8—equatorial view, mid-focus: I-34-2.

PLATE 4

EXPLANATION OF PLATE 5

Edmonton Formation

"zones" A and B

Central Alberta

Magnification X1000

Figures 1,2: _Cingulatisporites dakotaensis_ Stanley; 1—mid-focus view; 2—mid-focus view: I-50-2.

Figures 3, 4: _Cranwellia rumseyensis_ Srivastava; 3—high-focus showing striations, I-52-1; 4—mid-focus showing colpi, I-49-1.

Figures 5, 6: _Cupuliferoipollenites pusillus_ (Potonié) Potonié; 5—equatorial view, I-14-3; 6—equatorial view, I-19-2.

Figure 7: _Polypodiisporites_ sp.; equatorial view, I-25-1.

Figures 8, 9: _Scollardia steevesi_ Srivastava; 8—polar view, mid-focus, I-52-1; 9—oblique view showing colpi, I-49-1.

Figure 10: _Sphagnum regium_ Drozhastichich; mid-focus view, I-54-3.

Figures 11, 12: _Reticuloidosporites_ sp.; 11—equatorial view showing discontinuous reticulate pattern, I-40-3; 12—oblique view showing monolete mark, I-25-1.

Figure 13: _Tricolpites_ sp. B; polar view, mid-focus, I-40-3.

Figure 14: _Tricolpites_ sp. A; equatorial view, high-focus, I-34-2.

Figures 15, 16: _Kurtzipites_ sp.; 15—polar view, mid-focus, I-32-3; 16—polar view, mid-focus, I-40-3.

PLATE 5

EXPLANATION OF PLATE 6 (cont'd)

Figure 14: *Momipites tenuipolis* Anderson; polar view, mid-focus, showing thinning in polar region, I-5-3.

Figure 15: *Momipites inaequalis* Anderson; polar view, I-5-3.

Figure 16: *Tilia danei* Anderson; polar view, mid-focus, I-1-1.

EXPLANATION OF PLATE 6

Edmonton Formation

"zone" B

Central Alberta

Magnification X1000

Figure 1: Myrtaceidites sp. C; polar view, I-32-3.

Figures 2, 3: Rhoipites sp. cf. R. pisinnus; 2—equatorial view showing pore structures; 3—equatorial view showing reticulate pattern; I-32-3.

Figure 4: Betulaceoipollenites sp.; mid-focus view, I-30-2.

Figure 5: Myrtaceidites sp. A; polar view showing colpi and polar island, I-22-3.

Figure 6: Liliacidites sp.; proximal view showing reticulation and sulcus, I-26-1.

Figure 7: Myrtaceidites sp. B; polar view, I-19-2.

Figures 8, 9: Salixipollenites sp. B; 8—equatorial view showing reticulation; 9—equatorial view showing colpi: I-15-3.

Edmonton and Paskapoo Formations

"zones" B and C

Central Alberta

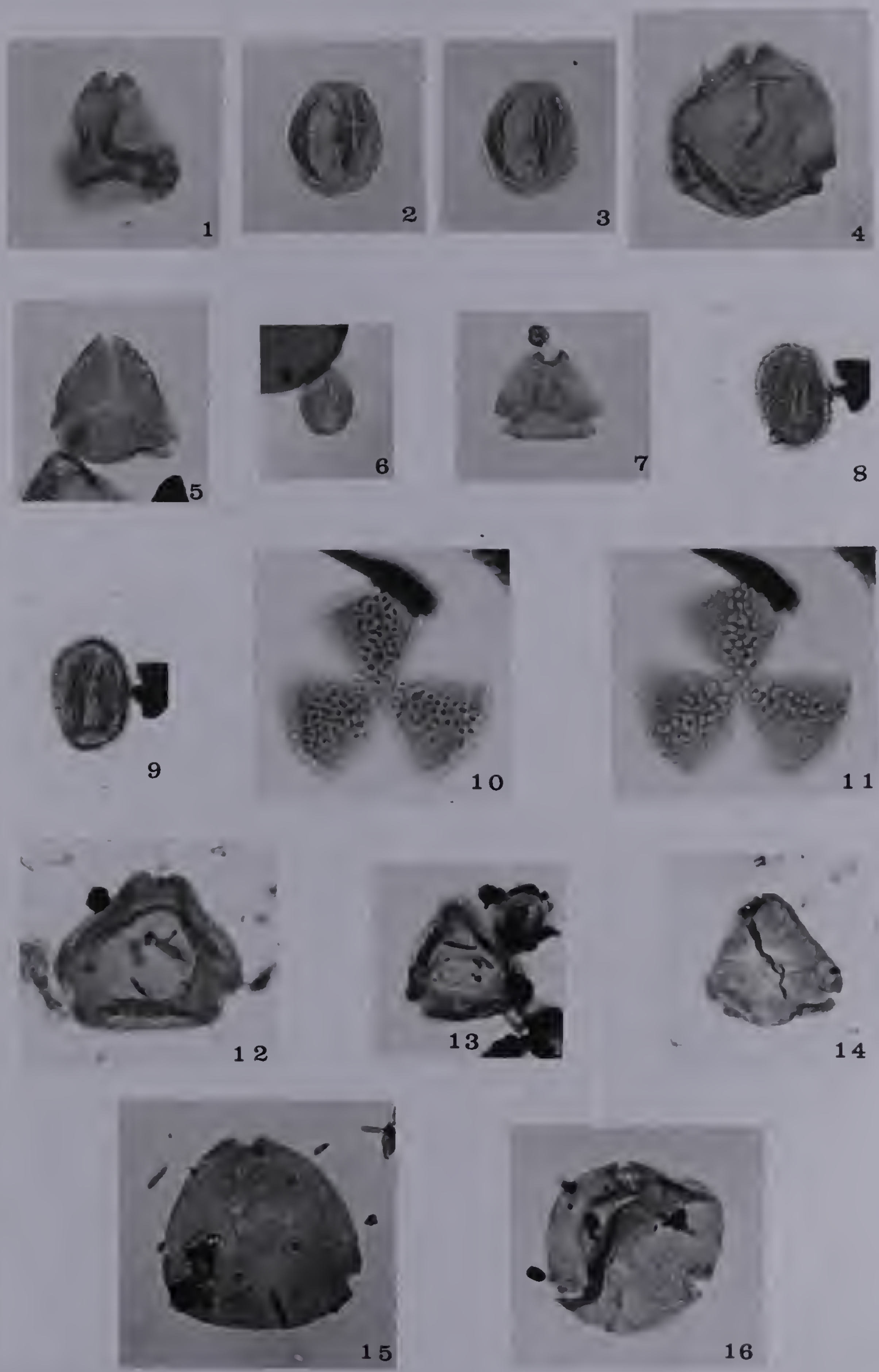
Magnification X1000

Figures 10, 11: Salixipollenites sp. A; 10—polar view, high-focus showing coarse reticulation; 11—polar view, mid-focus showing gradation in lumina size toward colpi and poles: I-1-2.

Figure 12: Ulmoideipites tricostatus Anderson; polar view showing arci and pore structures, I-5-3.

Figure 13: Alnus trina Stanley; polar view, I-1-1.

PLATE 6



EXPLANATION OF PLATE 7

Paskapoo Formation

"zone" C

Central Alberta

Magnification X1000 except where otherwise designated

Figure 1: Alnus verus (Potonié) Rouse; polar view, I-1-1.

Figures 2, 3: Aquilapollenites spinulosus Funkhouser; 2—equatorial view, I-8-2; 3—equatorial view, I-1-1.

Figures 4, 5, 6: Caryapollenites scabratus Groot and Groot; polar views, I-1-1.

Figure 7: Tilia tetraforaminipites Wodehouse; polar view, I-8-2.

Figures 8, 9: Vitis sp. cf. V? affluens Stanley; 8—polar view showing the very fine reticulate pattern; 9—polar view showing the thickened pore regions: I-6-2.

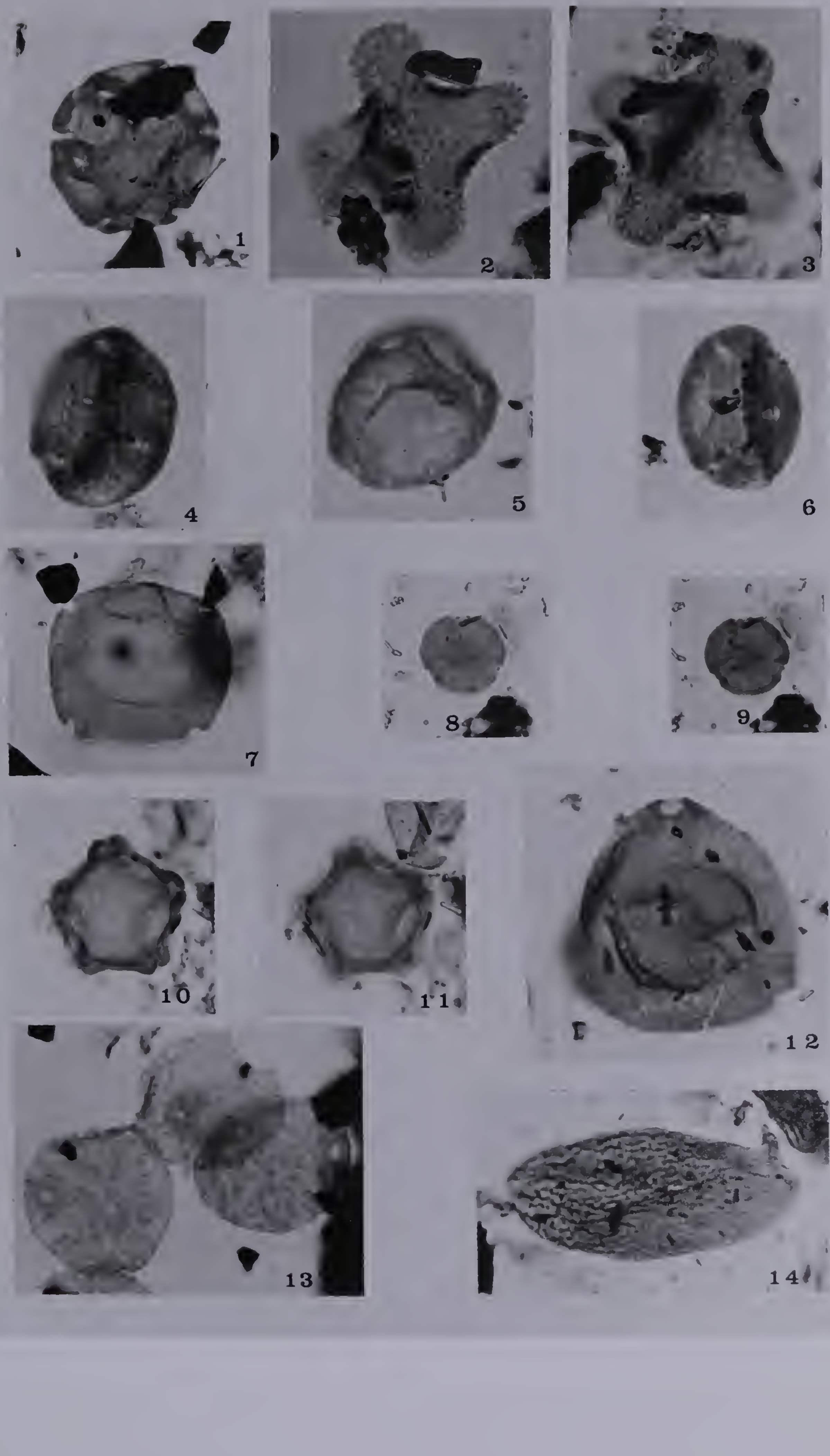
Figures 10, 11: Alnus rubriformis Simpson; 10—polar view, mid-focus showing vestibulums; 11—polar view, high-focus showing arci: I-5-3.

Figure 12: Carpinus subtriangula Stanley; polar view, I-5-3.

Figure 13: Pandanus sp? cf. P? shiabensis Simpson; mid-focus, I-4-2.

Figure 14: Ovoidites ligneolus (Potonié) Potonié; mid-focus, X500, I-5-3.

PLATE 7



EXPLANATION OF PLATE 8

Edmonton and Paskapoo Formations

"zones" A, B, C

Central Alberta

Magnification X1000

Figures 1, 2: *Laevigatosporites gracilis* Wilson and Webster; 1—distal view showing monolete mark; 2—equatorial view showing kidney-shaped outline: I-26-1.

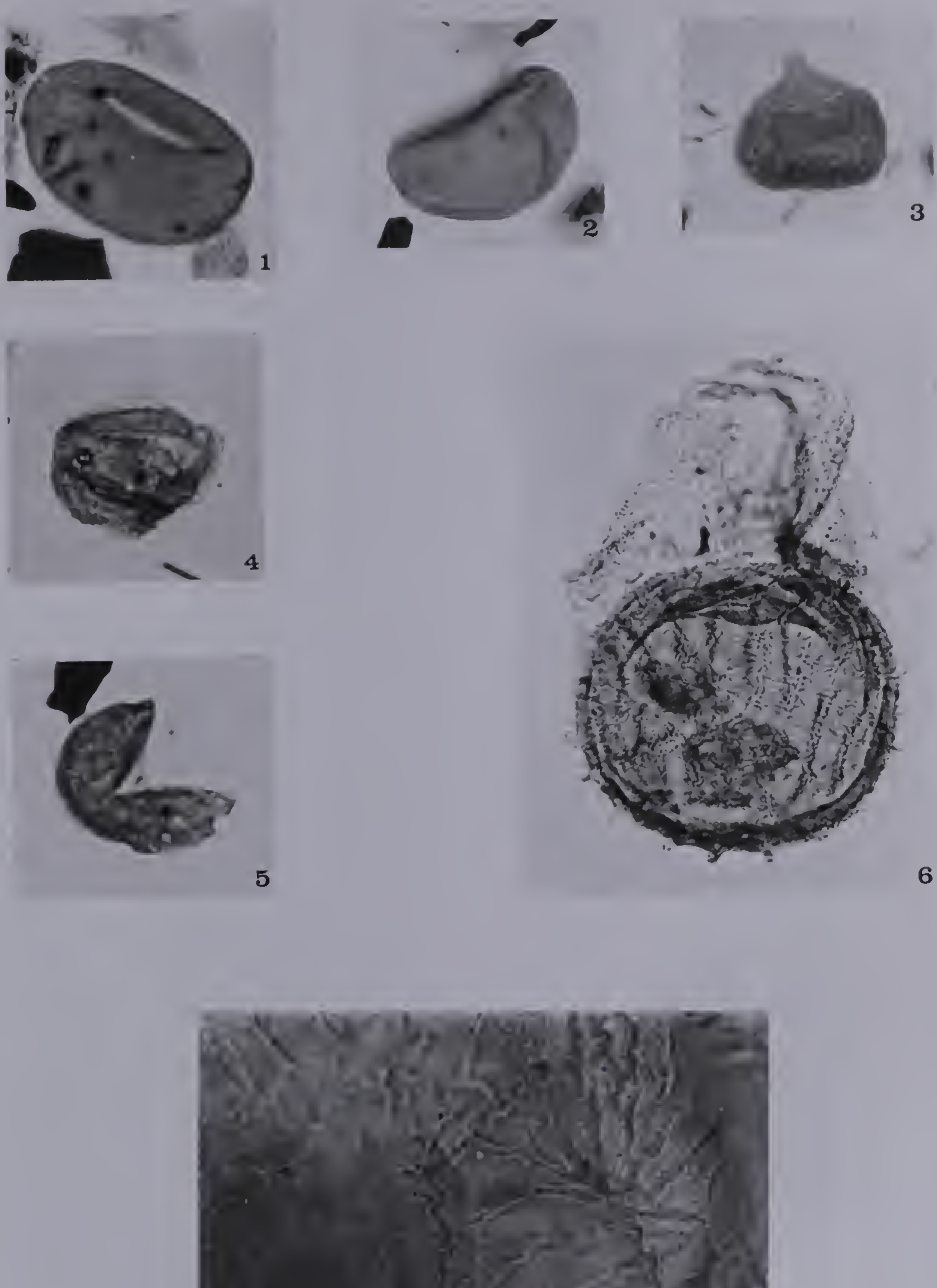
Figures 3, 4: *Sequoiapollenites paleocenicus* Stanley; 3—mid-focus showing granulate pattern; 4—low-focus showing ligula: I-25-1.

Figure 5: *Taxodiaceaepollenites hiatus* (Potonié) Kremp; high-focus showing granulate pattern: I-40-3.

Megaspores

Figures 6, 7: *Balmeisporites striatellus* Kondinskaya; 6—equatorial view, mid-focus showing the megaspore body and neck, X250; 7—plan view of outer layer showing the ridged and ribbed-like surface, X1000; ("zone" A) Edmonton Formation and St. Mary River Formation, central and southwestern Alberta, I-50-17M.

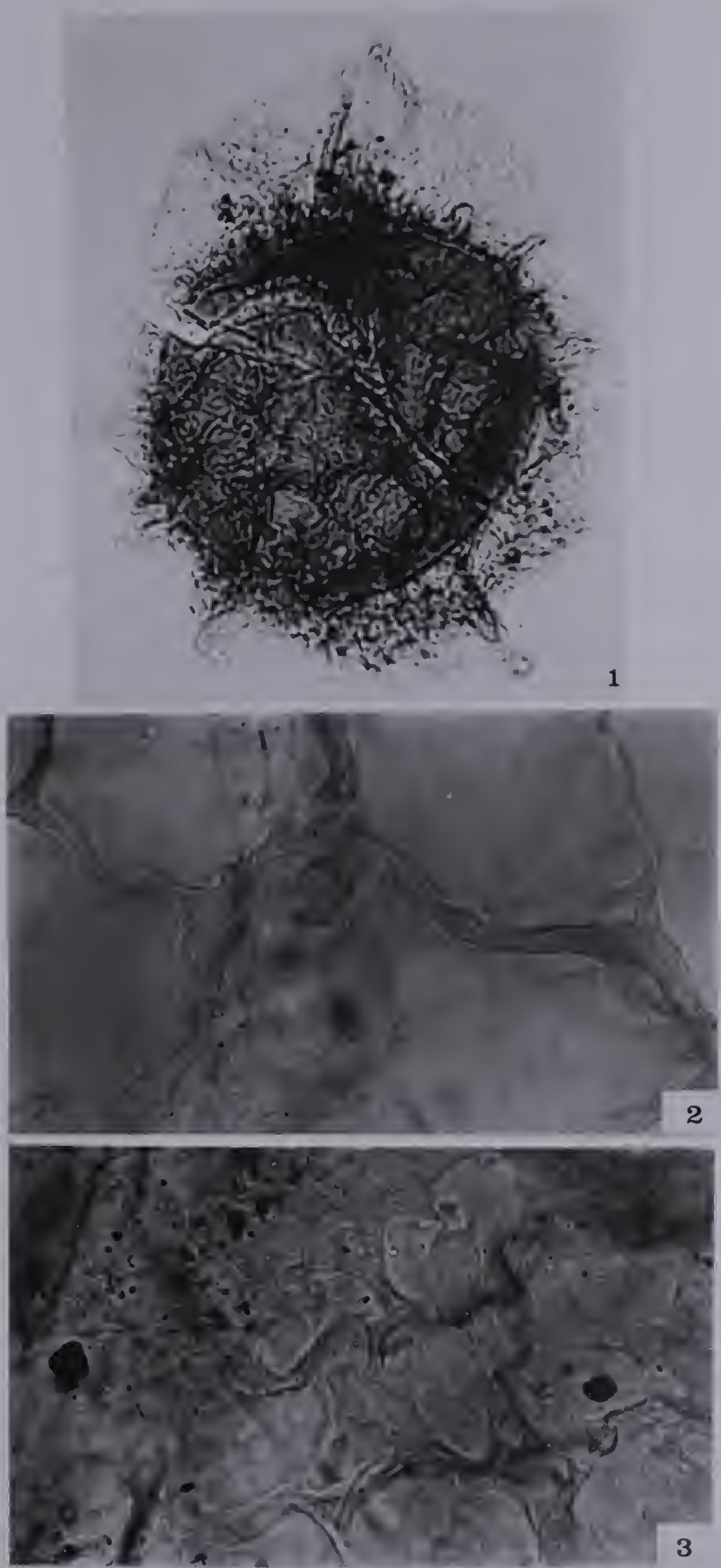
PLATE 8



EXPLANATION OF PLATE 9

Figures 1-3: Balmeisporites sp. A; 1—equatorial view, mid-focus showing the megaspore body and neck, X250; 2—plan view showing the outer layer, X1000; 3—plan view showing the central layer: ("zone" A) Edmonton Formation and St. Mary River Formation, central and southwestern Alberta, I-49-1M.

PLATE 9



1 2 3

EXPLANATION OF PLATE 10

Figures 1-3: Balmeisporites sp. B; 1—equatorial view, mid-focus showing the megaspore body and neck, X250; 2—plan view of the outer layer showing the crenulated muri juctions, X1000; 3—plan view of the outer layer showing the triangular-shaped lumina, X1000: ("zone" A) Edmonton Formation, central Alberta, I-50-3M.

PLATE 10

1

2

3

EXPLANATION OF PLATE 11

Figures 1,2: Balmeisporites sp. D; 1—equatorial view, mid-focus showing the megaspore body and neck, X250; 2—plan view of outer layer showing the converging rib pattern, X1000: ("zone" A) Edmonton Formation and St. Mary River Formation, central and southwestern Alberta, I-50-6M.

Figure 3: Balmeisporites sp. C; equatorial view, mid-focus showing the megaspore body and neck, X250, ("zone" A) Edmonton Formation, central Alberta, I-50-4M.

PLATE 11

1

2

3

EXPLANATION OF PLATE 12

Figures 1, 2: <u>Balmeisporites</u> sp. C; 1—plan view of the outer layer showing contorted muri, X1000; 2—plan view of the central layer showing the contorted muri, central layer visible in crossection on the right side of the figure, X1000: ("zone" A) Edmonton Formation, central Alberta, I-50-4M.

PLATE 12

1

2

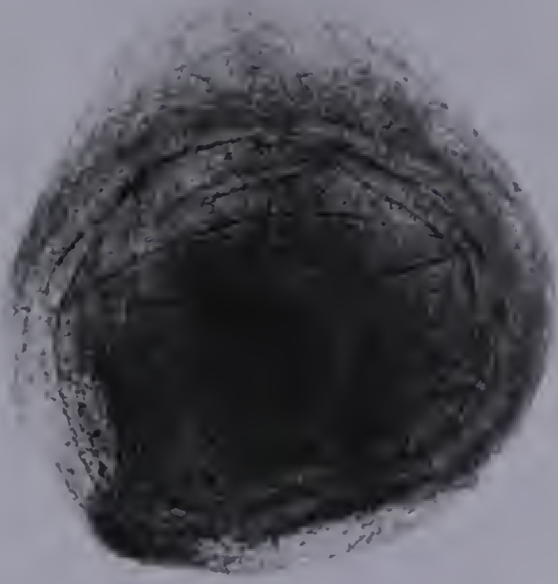
EXPLANATION OF PLATE 13

Figures 1-4: Azolla distincta n. sp.; 1—(holotype) high-focus view showing the megaspore body, "swimming apparatus" and a microspore massula attached to the megaspore body (lower left), X125, I-40-8M; 2—crossection view of megaspore wall and perispore lamellae, X1000, II-14-6M; 3—mid-focus view of megaspore showing the Y-shaped dehiscence mark on the megaspore wall, X125, I-14-4M; 4—plan view of the outer filamentous lamella, X1000, I-40-8M: ("zones" A, B and C) Edmonton and Paskapoo Formations, and Willow Creek Formation, central and southwestern Alberta.

PLATE 13

1

2



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4

EXPLANATION OF PLATE 14

Figures 1-3: Azolla distincta n. sp.; 1—plan view of the outer central lamella showing the reticulate structure with broad muri, X1000; 2—plan view of the outer and inner central lamella, X1000; 3—plan view of the megaspore wall, X1000: ("zones" A, B and C) Edmonton and Paskapoo Formations, and Willow Creek Formation, central and southwestern Alberta, II-14-6M.

PLATE 14

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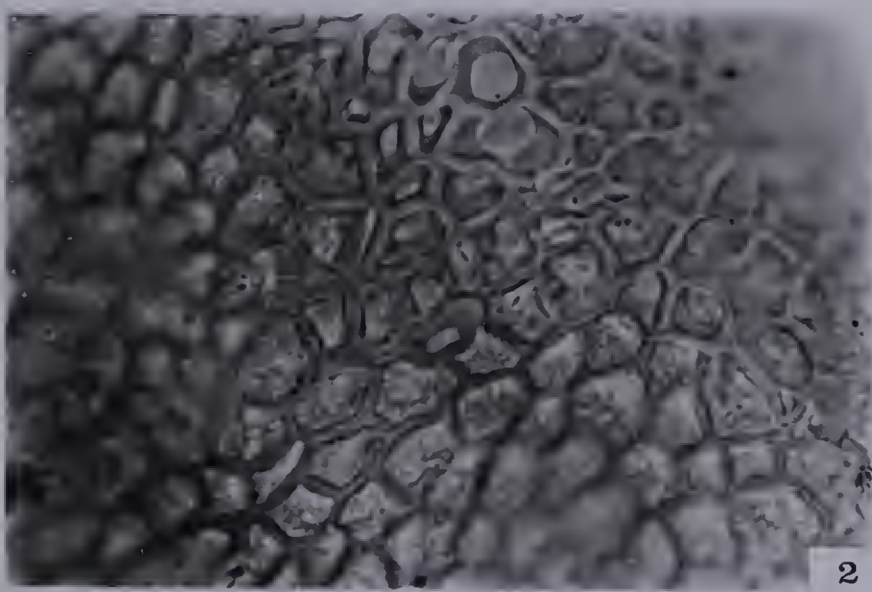

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EXPLANATION OF PLATE 15

Figures 1-4: *Azolla filosa* n. sp.; 1—(holotype) mid-focus showing the megaspore body and the "swimming apparatus", X125, I-34-11-2M; 2—crossection view of megaspore wall and perispore lamellae, X1000, I-34-6M; 3—plan view of the filamentous outer lamella, X1000, I-34-6M; 4—plan view of the megaspore wall showing the Y-shaped dehiscence mark, X1000, I-34-6M: ("zones" A and B) Edmonton Formation, central Alberta.

PLATE 15

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EXPLANATION OF PLATE 16

Figures 1-3: Azolla barbata n. sp.; 1—(holotype) mid-focus showing the megaspore body and "swimming apparatus", X125, I-34-14M; 2—crossection view of megaspore wall and perispore lamellae, X1000, I-34-11-1M; 3—plan view of the outer lamella showing the foveolate structure, X1000, I-34-14M: ("zone" A) Edmonton Formation, and Willow Creek Formation, central Alberta.

PLATE 16

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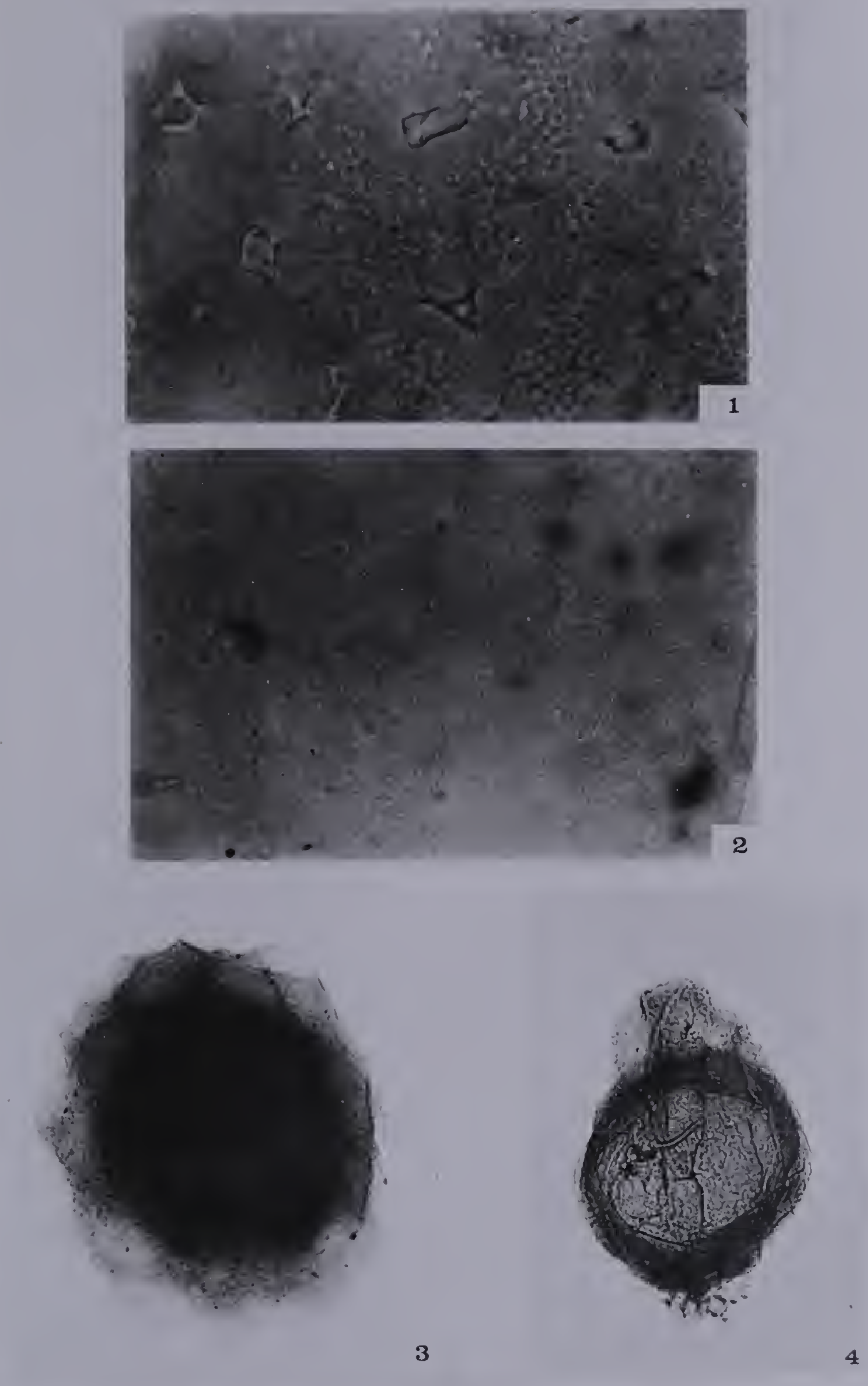
EXPLANATION OF PLATE 17

Figures 1,2: *Azolla barbata* n. sp.; 1—plan view of central lamella showing the columellae and fused areas around the fovea, X1000; 2—plan view of the megaspore wall, X1000: ("zone" A) Edmonton Formation, and Willow Creek Formation, central Alberta, I-34-14M.

Figures 3, 4: *Azolla pilata* n. sp.; 3—(holotype) high-focus showing the megaspore body and cushion-like columella, X125, I-34-10-3M; 4—mid-focus showing the megaspore body with most of the perispore and columella removed, X125, I-34-4M: ("zone" B) Edmonton Formation, central Alberta.

PLATE 17



EXPLANATION OF PLATE 18

Figures 1-4: Azolla pilata n. sp.; 1—crossection view of megaspore wall and perispore lamellae, X1000, I-34-10-2M; 2—plan view of filamentous outer lamella, X1000, I-34-10-3M; 3—plan view of inner lamella, X1000, I-34-10-1M; 4—plan view of the smooth megaspore wall, X1000, I-34-10-1M: ("zone" B) Edmonton Formation, central Alberta.

PLATE 18

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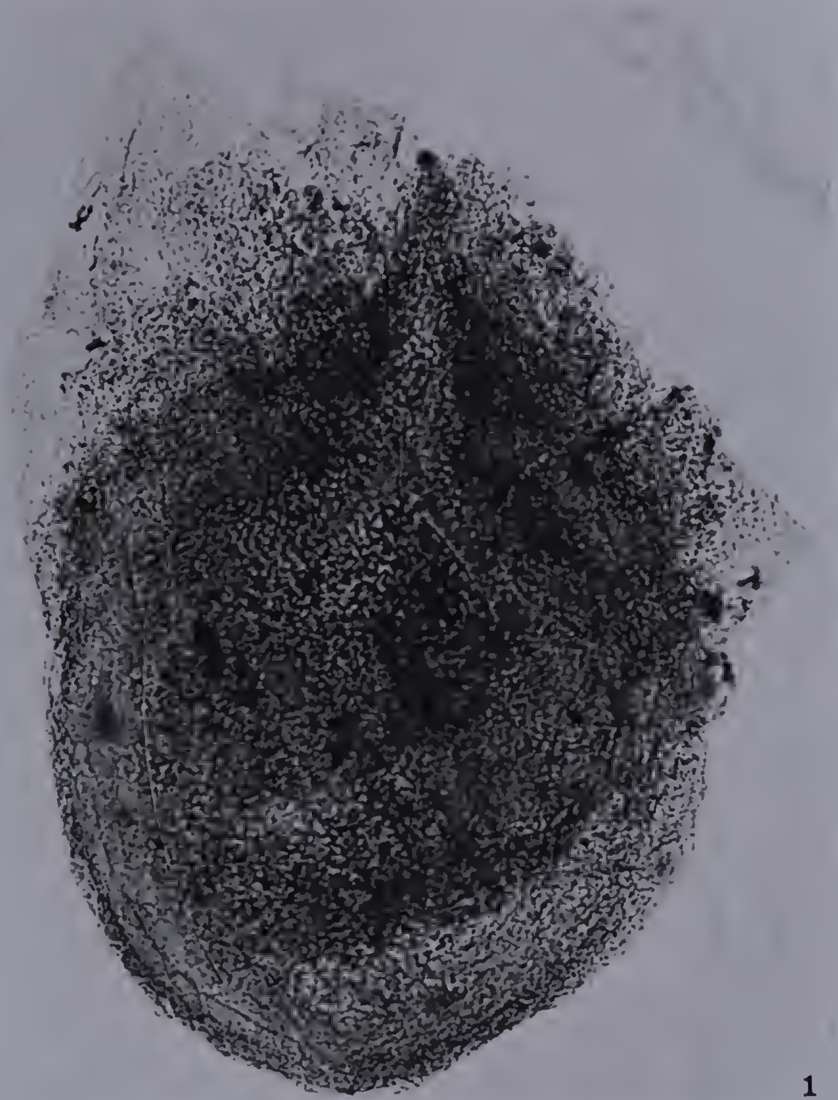
EXPLANATION OF PLATE 19

Figures 1, 2: *Azolla conspicua* n. sp.; 1—(holotype) mid-focus showing the megaspore body, "swimming apparatus" and Y-shaped dehiscence marks on the megaspore wall and the perispore, X125, I-52-2M; 2—crossection view of megaspore wall and perispore lamellae, X1000, I-52-2M: ("zone" A) Edmonton Formation, and St. Mary River Formation, central and southwestern Alberta.

PLATE 19



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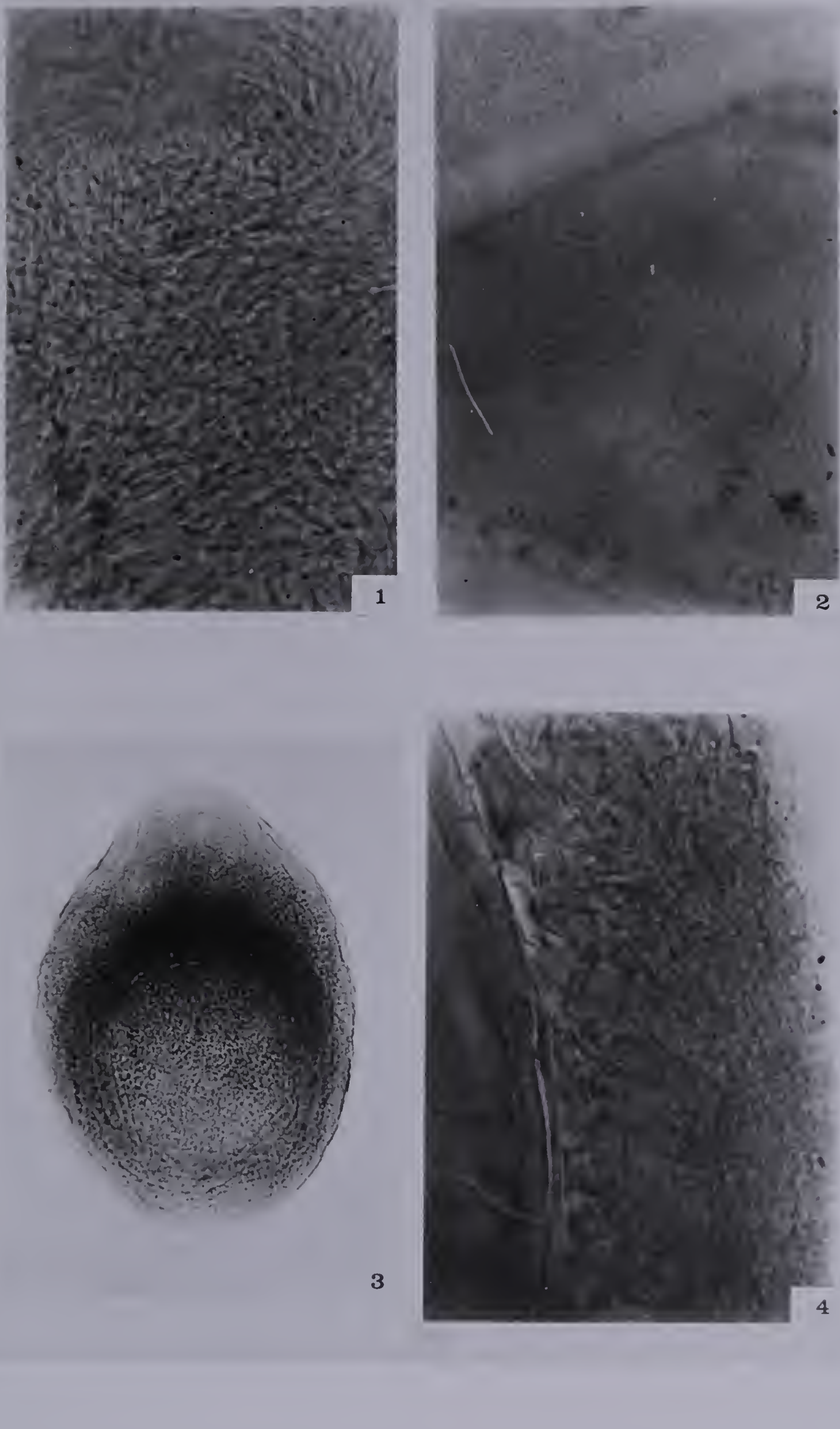
EXPLANATION OF PLATE 20

Figures 1,2: Azolla conspicua n. sp.; 1--plan view of filamentous outer lamella, X1000, I-52-2M; 2--plan view of megaspore wall, X1000, I-52-2M: ("zone" A) Edmonton Formation, and St. Mary River Formation, central and southwestern Alberta.

Figures 3, 4: Azolla fistulosa n. sp.; 3--(holotype) mid-focus showing the megaspore body and "swimming apparatus", X125, IV-4-9M; 4--crossection view of megaspore wall and perispore lamellae, X1000, IV-4-5M: ("zone" B) Edmonton Formation, central Alberta.

PLATE 20



1 2 3 4

EXPLANATION OF PLATE 21

Figures 1-3: <u>Azolla fistulosa</u> n. sp; 1—plan view of filamentous outer lamella; 2—plan view of spongy central lamella showing the cellular network; 3—plan view of the megaspore wall: X1000, ("zone" B) Edmonton Formation, central Alberta, IV-4-5M.

PLATE 21

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EXPLANATION OF PLATE 22

Figures 1-4: Azolla lauta n. sp.; 1—(holotype) mid-focus showing the megaspore body, "swimming apparatus" and Y-shaped dehiscence mark on the megaspore wall, X125, I-34-2M; 2—cros-section of the megaspore wall and the peri-spore lamellae, X1000, I-34-1-1M; 3—plan view of the central lamella showing the fossulae-like grooves, X1000, I-34-1-1M; 4—plan view of the megaspore wall, X1000, I-34-4M: ("zones" A and B) Edmonton Formation, and Willow Creek Formation, central and southwestern Alberta.

PLATE 22

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EXPLANATION OF PLATE 23

Figures 1-4: <u>Azolla</u> <u>bulbosa</u> n. sp.; 1—(holotype) high-focus showing the megaspore body and "swimming apparatus", X125, I-8-1M; 2—mid-focus showing the megaspore body and cushion-like columella with the float-like structures removed, megaspore wall seen detached from the perispore and folded down toward the distal end of the megaspore, X125, I-8-6M; 3—crossection of megaspore wall and perispore lamellae, X1000, I-8-21M; 4—plan view of outer lamella showing bulbous protrusions, X1000, I-8-21M: ("zone" C) Paskapoo Formation, central Alberta.

PLATE 23

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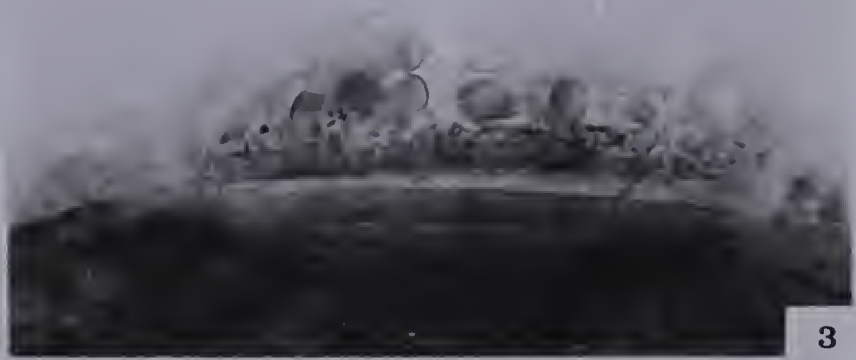

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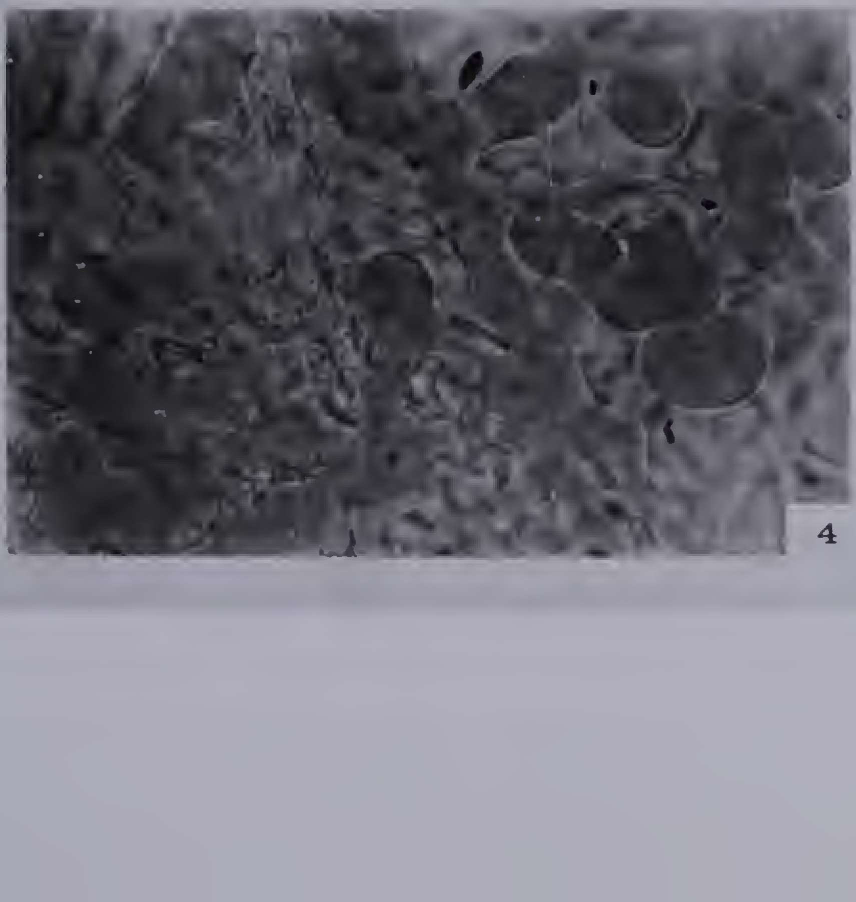

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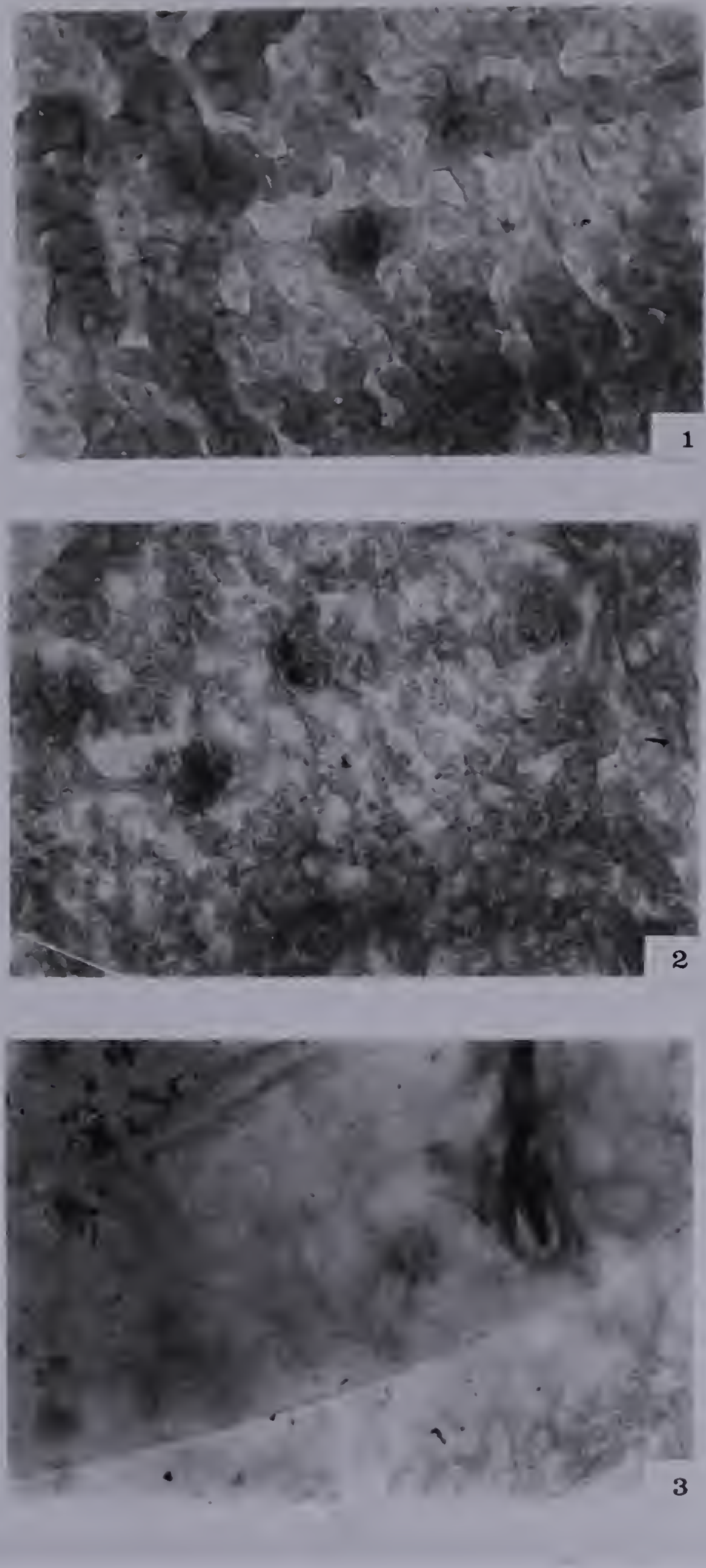
EXPLANATION OF PLATE 24

Figures 1-3: Azolla bulbosa n. sp.; 1—plan view of outer lamella showing irregular reticulation, X1000; 2—plan view of inner lamella showing faint granulate structure, X1000; 3—plan view of megaspore wall, X1000: ("zone" C) Paskapoo Formation, central Alberta, I-8-21M.

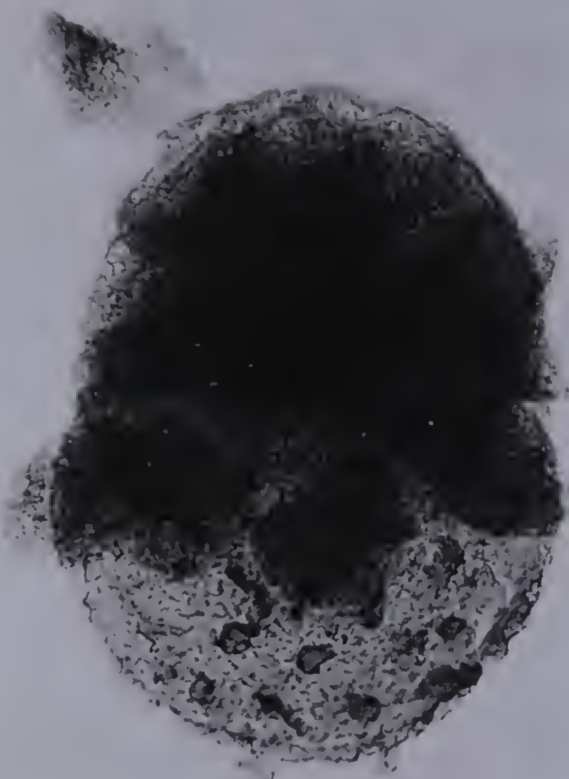
PLATE 24



EXPLANATION OF PLATE 25

Figures 1-3: _Azolla teschiana_ Florschütz; 1—high-focus showing megaspore body, "swimming apparatus", and protrusions on outer perispore surface, X125, slide T-6, co-ord. 12.4/81.8; 2—mid-focus showing megaspore body, "swimming apparatus" and collapsed megaspore wall, X125, slide T-5, co-ord. 13.5/97.3; 3—cros-section view of megaspore wall and perispore lamellae, X1000, slide T-2, co-ord. 8.5/76.8.

PLATE 25



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EXPLANATION OF PLATE 26

Figures 1-3: Azolla teschiana Florschütz; 1—plan view of outer lamella showing protrusions, X1000; 2—plan view of outer lamella showing irregular reticulation, X1000; 3—plan view of megaspore wall, X1000: slide no. T-5, co-ord. 13.5/97.3.

PLATE 26

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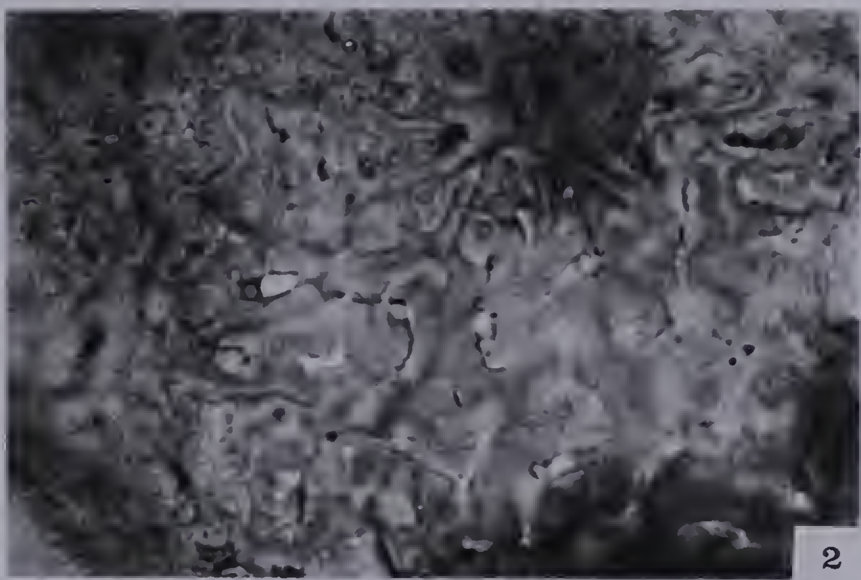

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EXPLANATION OF PLATE 27

Figures 1-3: *Azolla schopfi* Dijkstra; 1—mid-focus showing the megaspore body and "swimming apparatus", X125, I-26-12M; 2—crossection view of megaspore wall and perispore lamellae showing a well developed pore structure, X1000, I-14-1M; 3—plan view of outer lamella showing randomly distributed pore spaces, X1000, I-14-1M: ("zones" A, B and C) Edmonton and Paskapoo Formations, and Willow Creek Formation, central and southwestern Alberta.

PLATE 27

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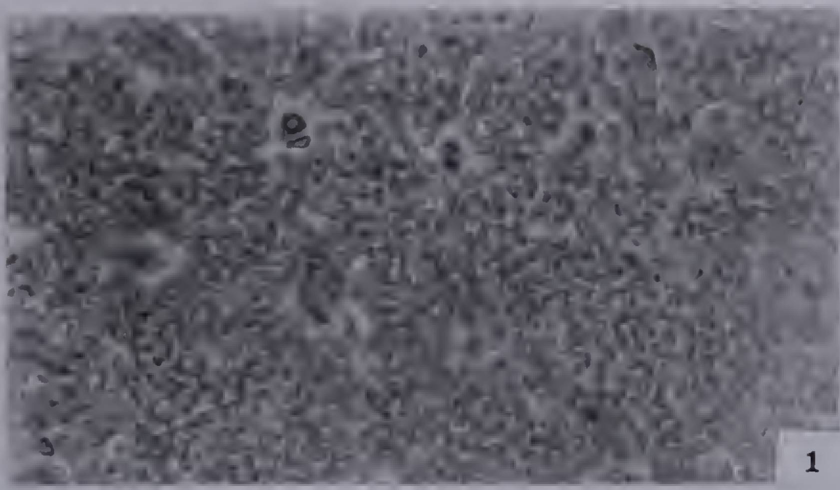
EXPLANATION OF PLATE 28

Figures 1-3: _Azolla_ _schopfi_ Dijkstra; 1—plan view of central lamella showing columellae and pore structures, X1000; 2—plan view of smooth inner lamella showing distinct pore structures, X1000; 3—plan view of megaspore wall, X1000: ("zones" A, B and C) Edmonton and Paskapoo Formations, and Willow Creek Formation, central and southwestern Alberta, I-14-1M.

PLATE 28



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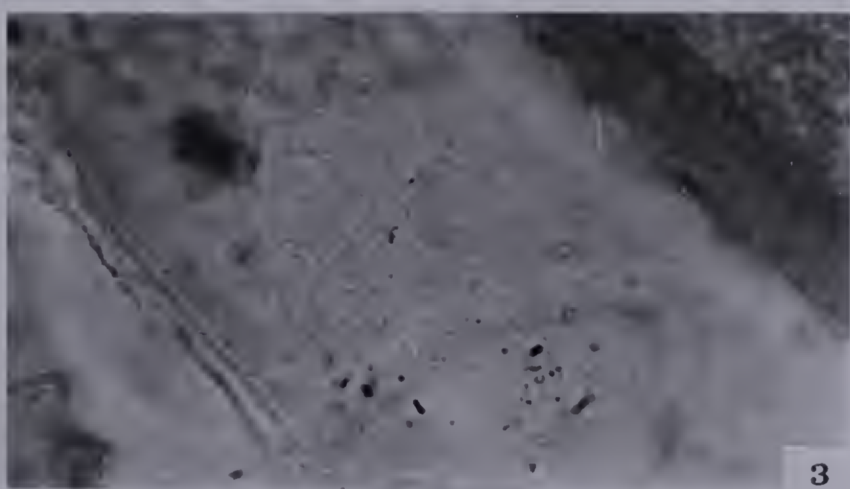

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EXPLANATION OF PLATE 29

Figures 1-4: *Azolla schopfi* Dijkstra; 1—mid-focus showing megaspore body and "swimming apparatus", X125, slide no. S-4, co-ord. 11.7/81.4; 2—crossection view of megaspore wall and perispore lamella, X1000, slide no. S-3, co-ord. 12.7/79; 3—plan view of outer lamella showing randomly distributed pore structures, X1000, slide no. S-3, co-ord. 12.7/79; 4—plan view of central lamella showing columellae and pore structures, X1000, slide no. S-3, co-ord. 12.7/79.

PLATE 29

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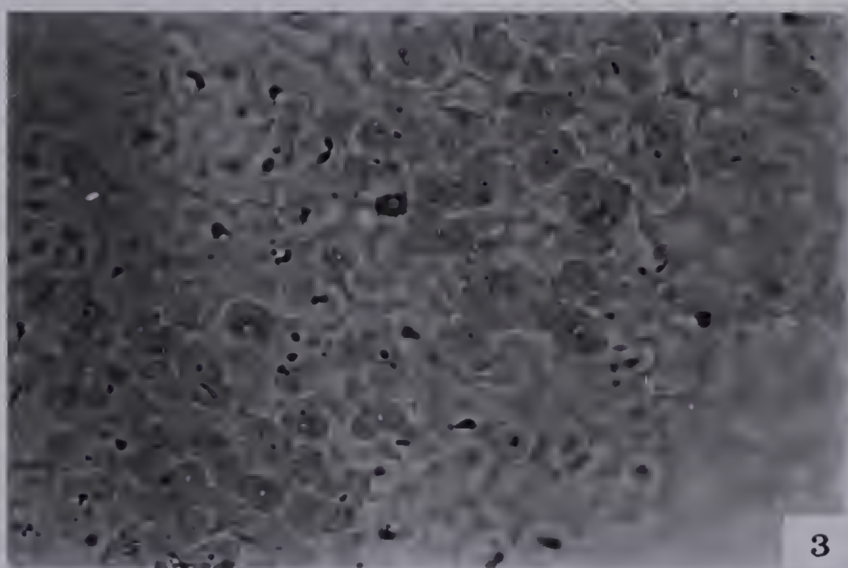

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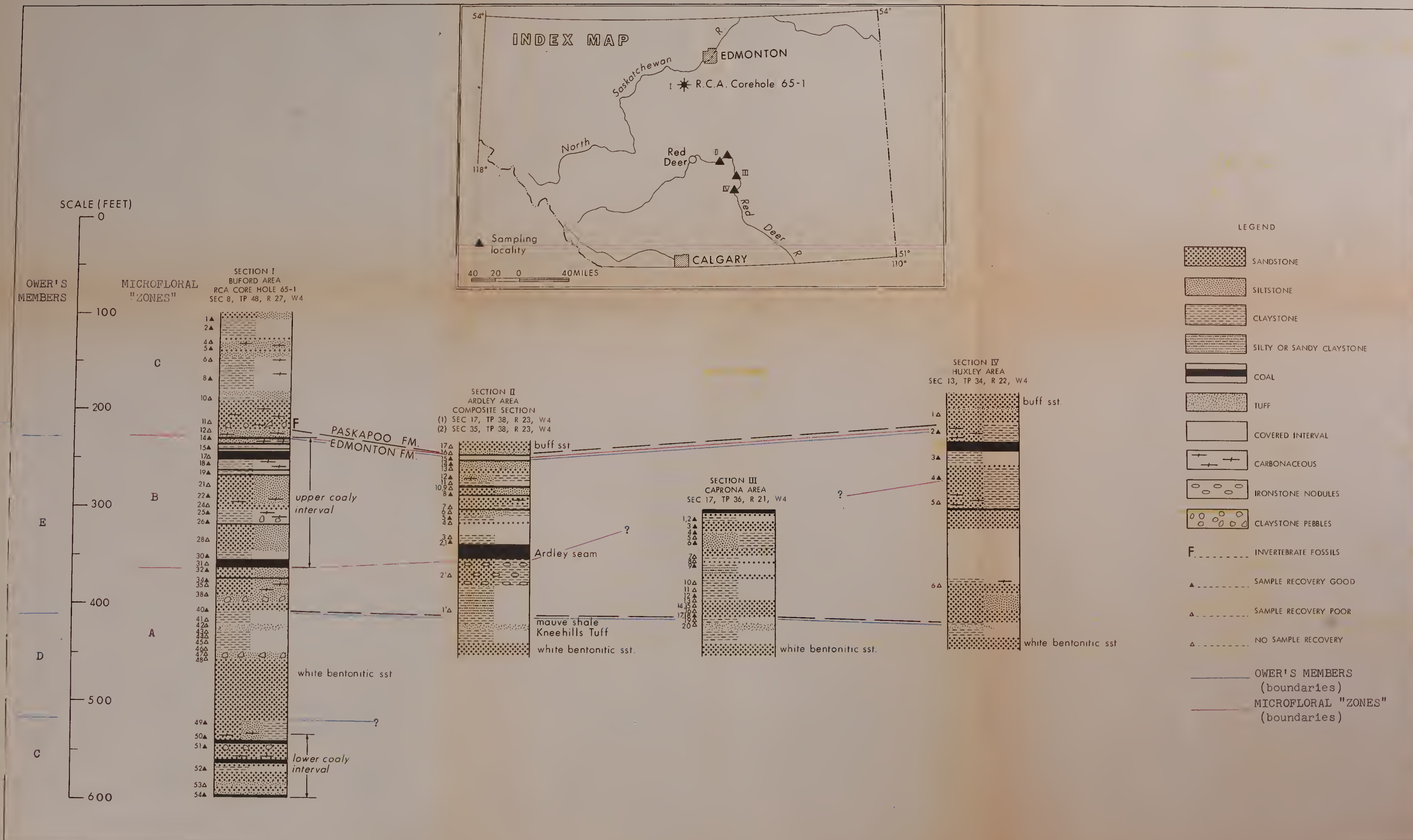

FIGURE 2. Columnar Sections of R.C.A. No. 65-1 Core and Red Deer River Valley Outcrops.